DOCUMENT RESUME

ED 115 956	CE 005 851

AUTHOR	Powers, Thomas F.; Swinton, John R.
TITLE	Parameters of the Future Food Service World of Work. A Report.
INSTITUTION	Pennsylvania State Univ., University Park. Food Service and Housing Administration.
SPONS AGENCY	Pennsylvania Research Coordinating Unit for Vocational Education, Harrisburg.
REPORT NO	VT-102-348
PUB DATE	30 Jun 74
NOTE	616p.
EDRS PRICE	MF-$1.08 HC-$31.10 Plus Postage
DESCRIPTORS	Annotated Bibliographies; *Economic Factors; *Food Service Industry; Futures (of Society); Labor Economics; Labor Force; Nutrition; Planning; Population Trends; *Reference Materials; *Research Reviews (Publications); State of the Art Reviews; Tables (Data); *Trend Analysis

ABSTRACT

The document is a study of the food service industry intended for use as a reference by food service teachers and curriculum planners. The purpose of the study is to map the economic and technological territory of the industry, to identify the dynamics shaping the industry today, and to consider questions crucial to an orderly consideration of the future. In the section on industry dynamics, a principal focus of concern is on labor cost and supply and on the productivity of labor. Other major topics are food processing equipment and methods, nutrition, and economic trends. The effects of demography and migration on the demand for food service are also considered. Bibliographic essays place the main points of the source materials into an overview context in narrative and sequential form. Bibliographies follow each section. (Author/NJ)

Documents acquired by ERIC include many informal unpublished materials not available from other sources. ERIC makes every effort to obtain the best copy available. Nevertheless, items of marginal reproducibility are often encountered and this affects the quality of the microfiche and hardcopy reproductions ERIC makes available via the ERIC Document Reproduction Service (EDRS). EDRS is not responsible for the quality of the original document. Reproductions supplied by EDRS are the best that can be made from the original.

ED115956

A REPORT

PARAMETERS OF THE FUTURE FOOD SERVICE WORLD OF WORK

Project Number: 19-3022

School Unit: 4-10-14-720-1

U S DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
NATIONAL INSTITUTE OF
EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

Submitted to

Dr. Carroll A. Curtis,
Director

PENNSYLVANIA DEPARTMENT OF EDUCATION

BUREAU OF VOCATIONAL EDUCATION

RESEARCH COORDINATING UNIT

by

Thomas F. Powers, Ph.D.,
Professor in Charge,

with the assistance of

John R. Swinton,
Research Assistant

Food Service and Housing Administration

Human Development Building
THE PENNSYLVANIA STATE UNIVERSITY
University Park, Pennsylvania 16801

June 30, 1974

CE 005 851

VT-102-348

Acknowledgments

Acknowledgments in a project of this scope can never be adequate, but I want to give credit where credit is due in spite of the danger of an omission. First, my thanks go to the Research Coordinating Unit Director of the Pennsylvania Department of Education's Bureau of Vocational Education, Dr. Carroll A. Curtis and his staff. And particular thanks also go to the RCU's Dr. Clarence Dittenhafer, who endured a long series of efforts to conceptualize this project. He did so with patience, offering many useful insights and a willingness to bear with some initial wrong turns. Without the added encouragement and support of Miss Caroline Kratz, Senior Program Specialist in Home Economics at the Pennsylvania Department of Education, and her staff, this effort would almost certainly have been impossible.

John Swinton, who provided the project with editorial assistance, managed to bring this volume together without friction within time constraints that would have made weaker men cringe. His is the major merit for clarity in presentation; given the difficulty of the subject matter, he cannot be blamed if some of us seem a bit plodding. His voice shaped the concept of the project and its continuation, just as his hand shaped this final product.

Encouragement, too, came from the food service professionals who agreed to help with this project: Dick Benefield, President of the Pennsylvania Hotel and Motor Inn Association; William Lapitsky also of the Association; Ms. Jane Armstrong, Vice President for Consumer

Affairs of the Jewell Tea Company; and Ms. Josephine Martin of the Georgia State Department of Education, School Food Service. The time frame within which we worked did not permit us to make as full a use of these distinguished professionals as we had planned; but they offered their encouragement, and they continue to offer their knowledge. Ms. Hester Munden, Home Economics Consultant of the Pennsylvania Department of Education served with this group, suffered through an early presentation of some of the material in this study, offered encouragement, and agreed to serve as a consultant to the project in the future. We owe her a special note of thanks.

The Penn State graduate assistants, those foot soldiers of academia, who worked so long and hard on this project deserve recognition: Mark C. Schechter, Russell J. Profozich, and James R. Wible (Economics); Stephen Bartlett (Engineering); Barbara Bollinger (Food Science); Jack L. Nasar and Lawrence A. Swanson (Man-Envoronment Relations); Colleen Patterson Greecher (Nutrition); and Jac Melamed (Food Service and Housing Administration).

Nancy Goerisch, who worked closely with me on the project, deserves particular mention. Not only did she do much of the detailed research, but she also directed others in their research and suffered much of the administrative trivia related to carrying out the project.

Long, hard, constant, and often tense work was accomplished by a veritable corps of secretaries: Janet Villastrigo, Grace Collins, Bonnie Williams, and Ruth Kilhofer, the last of whom not only typed many drafts and final mats, but also produced many of the charts and appendices that appear herein. Rhoda Williams, who commanded this corps, endured all the special troubles that accompany responsibility with grace and patience, keeping everything else her office does running smoothly at the same time.

Finally, a personal word to our readers: Critical reactions to this volume will be most helpful to future research. I hope a realization of the time pressure under which this study was completed--seven months is not a long time even for such a modest effort as this--will bolster your patience. Because our purpose was to bring the tools of several disciplines to bear on the world of food service, you will probably find some unavoidable duplication. Nevertheless, I believe that this study offers some useful planning approaches and future considerations for food service workers, and I hope you agree.

Thomas F. Powers

June 28, 1974

University Park, Pennsylvania

TABLE OF CONTENTS

Acknowledgments iii

INTRODUCTION
- Thomas F. Powers xxi
- Food Science and Engineering xxiii
- Nutrition and Food Service xxv
- Economics and the Food Service Industry xxvi
- Industry Dynamics xxvii
- Function of this Volume xxviii

I. INDUSTRY DYNAMICS: AN INSTITUTIONAL VIEW
- Thomas F. Powers, Ph.D. 1
- Labor Cost, Labor Supply, and the Food Service Industry 3
  - Introduction 3
  - The Minimum Wage 3
  - Social Policy and Labor Supply 11
  - Where Are We? 15
  - Where Do We Go From Here? 18
- Notes 25
- The Impact of Productivity on the Service Restaurant 27
- Notes 41
- Toward a View of Industry Dynamics 43
  - Introduction 43
  - Supply Factors 43
  - Fashion, Style, and the Matter of Quality 44
  - Marketing 46
  - Fast Food and the Specialty Restaurant 48

Some Views of the Future 49

Toward a View of Industry Dynamics:
An Annotated Bibliography 53

II FOOD PROCESSING AND PREPARATION EQUIPMENT AS IT SHAPES THE FUTURE OF FOOD SERVICE

Frank W. Schmidt, Ph.D., and Stephen Bartlett 75

Introduction 77

Research in Heat Transfer 78

Food Processing and Preparation Equipment 82

Freezers and Refrigerators 82

Thawing Equipment 88

Ovens 90

Fat Fryers 100

Cookers 102

Broilers 104

Holding Equipment 104

Waste Disposal and Pollution Control 106

Completely Integrated Systems 109

Future Trends 117

General Trends 117

Technological Breakthroughs 122

Future Research 123

Appendix: Basic Principles of Heat Transfer 127

Heat Conduction 127

Heat Radiation 131

Heat Convection 132

Glossary 135

Food Processing and Preparation Equipments:
A Bibliography 141

III FOOD PROCESSING METHODS: THE STATE OF THE ART AND ITS FUTURE EFFECT ON FOOD SERVICE
Joseph H. Mac Neil, Ph. D. and Barbara Bollinger 145

Introduction 147

Food Dehydration: The Most Widely Used Method of Food Preservation 149

Air Drying 149

Spray Drying 157

Foam Drying 161

Drum Drying 167

Frozen Foods: The Fastest Growing World in the Universe of Food 169

Slow vs. Rapid Freezing 173

Freezing Methods 174

Cryogenic Freezing 178

Product Applications of Cryogens 182

Cost of the Cryogens 184

The Future of Frozen Foods 185

Food Canning: The Most Familiar Method of Food Preservation 187

Introduction 187

Asceptic Canning 191

Advantages to Asceptic Canning 192

Limitations on Asceptic Canning 194

Current Products and Processes 195

The Future of Asceptic Canning 199

Retortable Flexible Pouches 199

Potential Developments 201

Intermediate Moisture Foods (IMF) 203

  Chemical Preservatives 204

  Smoking 207

  Salting 209

  Sugars as Preservatives 210

Freeze Drying: So Far Only a Limited Commercial Success 213

  Microwaves and Freeze Drying 218

  Freeze Drying Mineral Solvents 219

  The Status of Industrial Application 219

  Conclusion 221

Irradiation as a Food Preservation Method 223

  Introduction 223

  Protein Supplements 228

  Vegetable Proteins 229

  The Future of Textured Plant Proteins 232

  Single Cell Protein 236

  Fish Protein Concentrate 239

  Whey as a Protein Source 241

  Applications of Microwave Energy 242

Food Processing Methods: A Bibliography 247

IV NUTRITION AS IT IS AFFECTING AND WILL AFFECT FOOD SERVICE
Barbara Shannon, Ph.D., and
Colleen Patterson Greecher 253

An Introductory Review of the Literature 255

  Current and Projected Trends which have Nutritional Implications 255

  New Food Products with Nutritional Attributes 256

The Nutrient Requirements of Humans, The Nutrient Composition of Meals, and the Role of the Food Service Industry in Meeting Human Nutrient Needs 258

Mass Feeding Programs, Their Impact on Nutritional Status, and Nutrition Education of the Public 262

Government Regulations that Relate to the Compositition of Food 266

Conclusions 269

Effect of Cooking and Processing on Nutrient Composition of Food 271

Effect of Cooking and Processing Food on Nutrients in General 271

Effect of Cooking and Processing on Flesh Foods 280

Freeze Dehydration of Flesh Foods 284

The Effects of Cooking and Processing on the Nutrient Value of Milk and Milk Products 286

Cooking and Processing Fruits and Vegetables 292

Effect of Cooking and Processing on Eggs 301

Effect of Cooking and Processing on Cereal and Cereal Products 302

Effect of Cooking on the Nutrient Content of Fats and Oils 303

Nutritional Value of Food Provided by "Convenience Food Service Systems" 305

Recent Developments Which May Have An Influence on Nutritional Quality of Meals Served in Mass Feeding Programs 311

New Methods of Menu Planning 311

Use of Formulated Nutritionally Modified Foods 314

Central Commissaries and Contract Service 321

Nutrient Labeling Regulations and Initial Reactions to Them 323

Introduction 323

Nutrient Labeling Regulations 323

Reactions of Nutritional Labeling 337

Three Areas for Future Research 345

Nutrition as it Affects and Will Affect Food Service: An Annotated Bibliography 347

V PLANNING ASPECTS AFFECTING THE FUTURE OF FOOD SERVICES: A STUDY OF PLANNING AND SPATIAL ISSUES
Eugene J. Bazan, Ph.D., Jack L. Nasar, and Lawrence A. Swanson 397

Structure of Population 399

Introduction 399

Structure of Population Patterns 401

Trends in Population Patterns 412

Life Style, Activities, and Leisure Time Patterns 414

Structures of the Food Services Sector 419

Introduction 419

Institutional Trends in the Food Services Sector 419

Structural Trends in the Food Services Sector 424

Structure and Trends of Population and Food Services for Pennsylvania 429

Introduction 429

Method 429

Results 431

Scenarios for the Pennsylvania Food Service Sector 441

Introduction 441

The Scenarios 441

Methodological Issues and Areas for Further Research 447

Appendix 449

Planning Aspects Affecting the Future of Food Service: A Bibliography 453

Zoning Cases 458

VI ECONOMIC TRENDS INFLUENCING THE FUTURE OF THE FOOD SERVICE INDUSTRY
James D. Smith, Ph.D., Mark C. Schechter, Russell J. Profozich, and James Wible 461

Introduction: The Demand for Food 463

Income 464

Population 464

Consumer Preferences 464

The Price of Substitutes 463

Food Expenditures as a Proportion of Family Income by Income Class and Family Size 467

Total Food Consumption 467

Home Food Consumption 468

Away-From-Home Food Consumption 468

Interpretation 469

The Food Supply System of the United States 473

Introduction 473

Flow of Food Products 473

Labor in the Supply Process 474

Consumer Outlets 474

Static Analysis of Food Supply and Labor Utilization: 1965 and 1969 476

The Flow of Food Products 479

Introduction 479

Part I: A Summary of a Study on the Market for Food Served Away From Home 481

Part II: The Value of Food and Nonalcoholic Beverages in Eating Places in 1969 484

Bibliography 489

Appendix: Tables I, II, III, and IV, and Accompanying Footnotes 491

The Bureau of Labor Statistics (BLS)Employment Model 503

Introduction 503

Overview of the BLS Employment Model 503

Assumptions, Terms, and Methodology 505

Bibliography 509

The U. S. Food Industry and Labor Force: Projections to 1985 511

Introduction 511

The Food Industry and Labor Force: 1960's 512

The Food Industry and Labor Force: Projections 520

Bibliography 539

Conclusion to the Economics Section of the Food Services Futures Report 547

A Bibliography of the Economics of Food Consumption 549

Preface 549

The Bibliography 550

ADDENDA 609

A List of

Figures, Tables and Charts

I INDUSTRY DYNAMICS: AN INSTITUTIONAL VIEW

Labor Cost, Labor Supply, and the Food Service Industry

Figure 1: Increase of Minimum Wage 1938 to 1973 5

Figure 2: Average Hourly Earnings of Production (Nonsuperviosry) Workers on Nonagricultural Payrolls 1947 to 1970 6

Figure 3: Average Weekly Earnings of Production (Nonsupervisory) Workers on Private Nonagricultural Payrolls 1947 to 1970 8

Figure 4: Average Weekly Earnings of Food/Drink Establishments and Hotels/Motels Compared to Indices of Economic Productivity 1947 to 1970 9

Figure 5: Average Monthly Benefits AFDC General Assistance and Unemployment Compared to Average Monthly Wages for Food Service and Hotel/Motel Establishments 12

Table 1: Changes in Average Minimum Wage and Non-Wage Incomes in New York State 13

Table 2: Changes in AFDC Payments, Benefits and Recipients in New York State 13

Figure 6: Work Force Size: New York City Compared to United States 16

Impact of Productivity on the Service Restaurant

Table 1: Operating Profile of 25 Food Service Operations 29

Table 2: Ratio of Productive Man Hours to Total Man Hours 29

Table 1A 30

Table 3: Summary of Manhour Requirements for 25 Food Service Operations 32

Table 4: Productivity on Food Service Establishments 32

Table 5: Change in Number of Firms, United States Restaurant Industry, 1960-1969 35

Table 6: Change in Number of Firms, United States Restaurant Industry, 1960-1971, Estimated 35

II FOOD PROCESSING AND PREPARATION EQUIPMENT AS IT SHAPES THE FUTURE OF FOOD SERVICE

Figure 1: Basic Heat Pipe Configuration 81

Figure 2: "Crown X" Forced Convection Oven (7) 92

Figure 3: A Microwave Oven 98

Figure 4: NEFF Steam Cooker (4) 110

Figure 5: NEFF Water Cooker (10) 110

Figure 6: NEFF Grill (10) 112

Figure 7: NEFF Broiler (10) 112

Appendix

Table 1: Thermal Conductivity of Different Materials 128

Table 2: Thermal Diffusivities of Different Materials 129

Table 3: Convective Heat Transfer Coefficient 133

III FOOD PROCESSING METHODS: THE STATE OF THE ART AND ITS FUTURE EFFECT ON FOOD SERVICE

Table 1: Value of All Frozen Foods From 1942 Through 1972 170

Table 2: 1972 Frozen Food Poundage and Dollar Values 172

Table 3: Cost of Various Drying Operations 216

Table 4: Current and Estimated Fabricated Food Markets (1972-1980) 234

Table 5: Soy Protein Foods 235

IV NUTRITION AS IT IS AFFECTING AND WILL AFFECT FOOD SERVICE

Table 1: United States Recommended Daily Allowances 327

Table 2: Nutrition Information 328

Table 3: Examples of Labels 330

Table 4: Minimum Levels of Nutrients for Frozen "Heat and Serve" Dinners 336

V PLANNING ASPECTS AFFECTING THE FUTURE OF FOOD SERVICES: A STUDY OF PLANNING AND SPATIAL ISSUES

Figure 1: Lorenz Curves Comparing Population and Area by Towns and Villages, Scholarie County, 1870-1960 400

Figure 2: Population of Urbanized Areas Ranked by Size, 1950 402

Figure 3: U.S.A. 1790-1930. Communities of 2500 or More Inhabitants Ranked in the Decreasing Order of Population Size 403

Figure 4: India in 1911 and 1931. Communities Ranked in the Decreasing Order of Population Size 404

Figure 5: Manufacturing in the U.S.A. in 1939 When Ranked in the Order of the Decreasing Number of Manufacturers of Like Kind 405

Figure 6: Retail Stores (Including Chain Stores) in the U.S.A. in 1939 Ranked in Order of Decreasing Number of Stores of Like Kind 406

Figure 7: Log-normal Distribution of California Disposal Sites by Size (Daily Tonnage Received) 407

Figure 8: Distribution of Food Service Establishments 409

Figure 9: A Divided Market Region 411

Figure 10: Market Region Relationships 411

Figure 11: Activity Responses 416

Figure 12: Eating Establishment Sales Concentration 425

Figure 13: Eating Establishment Employee Concentration 426

Figure 14: Percentage of Multi-Unit Firms in Pennsylvania and the U.S. (1967) 427

Figure 15: Population Concentration Urban Places (A) 432

Figure 16: Population Concentration Rural Places (A) 433

Figure 17: Population Concentration Urban Places (B) 434

Figure 18: Population Concentration Urban Places (C) 435

Figure 19: Population Concentration Rural Places (B) 436

Figure 20: Population Concentration Rural Places (C) 437

Appendix Tables

Urban SMSA Places, 1970 449

Urban SMSA Places, 1960 450

Rural Non-SMSA Places, 1960 451

Rural Non-SMSA Places, 1970 452

VI ECONOMIC TRENDS INFLUENCING THE FUTURE OF THE FOOD SERVICE INDUSTRY

Food Expenditures as a Proportion of Family Income by Income Class and Family Size

Table 1: Total Food Consumption as a Percentage of After Tax Income, 1960-61 470

The Flow of Food Products: Appendix

Table I: 1969 Supply ralues (in billions of dollars)

Table II: 1965 Supply Values (in billions of dollars)

Table III: 1969 Labor Statistics

Table IV: 1965 Labor Statistics 491-502, incl.

The Bureau of Labor Statistics (BLS) Employment Model

Diagram: Interrelationships of Potential Gross National Product, Final Demand, Industry Production, Productivity, and Employment 506

The U.S. Food Industry and Labor Force: Projections to 1985

Table 1: Employees on Nonagricultural Payrolls, by Industry Divisions 1919-68 514

Table 2: Number and Average Hourly Earnings of Employees in Selected Nonmanufacturing Industries 1965-67 517

Table 3: Number and Average Hourly Earnings of Employees in Selected Nonmanufacturing Industries 1965-67 519

Table 4: Total Population, Total Labor Force, and Labor Rates by Age and Sex, Actual 1960 and 1970 and Projected 1980, 1985, and 1990 521

Chart 1: Year-to-Year Change in Total Labor Force, 1951-1985 522 and 523

Table 5: Distribution of Total Labor Force, by Age and Sex, Actual 1960 and 1970, and Projected 1980, 1985 and 1990 525

Chart 2: Total Population, Labor Force, and Participation Rates: U.S. Population, 1955-72, and Projected 1980-85 526

Chart 3: Total Labor Force, and Labor Force Participation Rates, Actual 1960-1970, and Projected 1980-1990 528

Table 6: Employment by Major Occupational Group, 1960 and 1972, and Projected 1980 and 1985 532

Table 7: Percent Distribution of Employment, by Major Occupational Group, 1960 and 1972, and Projected 1980 and 1985 532

Table 8: Productivity Change by Sector, Average Rate During Selected Periods, 1948-72 and Projected to 1980 and 1985 534

Table 9: Personal Incomes: Sources and Disposition, Selected Years 1955-72 and Projected to 1980 and 1985 539

ADDENDA

Figure 5: Wages, Check Average, and Total Covers in Three Food Service Operations 610

Figure 1: Total Food Expenditures as a Percentage of Income by Family Size 611

Figure 2: Total Food Expenditures by Income and Family Size 612

Figure 3: Away From Home Food Expenditures as a Percentage of Income, by Family Size 613

Figure 4: Away From Home Food Expenditures by Income and Family Size. 614

INTRODUCTION

Thomas F. Powers

In early 1972 the Food Service and Housing Administration (FSHA) Faculty at Penn State adopted a basic research aim: to identify the major forces shaping the food service industry with a view to understanding the probable direction of change in those industries. This is an interesting question, worthy of study in itself. The issues addressed are of vital importance to the food service industry. Most fundamentally, however, the need to study this issue results from the needs of curriculum planners at all levels of Food Service Education.

Recognizing the highly traditional structure of post secondary Hospitality Education, the Research Coordinating Unit (RCU) of the Pennsylvania Department of Education provided funds in 1971 for the redevelopment of Penn State's associate degree in Hotel and Food Service Management. Because of RCU's interest in Hospitality Education, FSHA approached that agency about a base line study to develop a picture of the Food Service industry of 1985-90 to provide necessary information for planning Vocational Technical food service curricula at the secondary level. With the support of the Home Economics staff of the Department of Education, RCU offered encouragement to our efforts.

Over the next year, a team of research scholars from across the University interested in this area were identified from the areas of food science, engineering, nutrition, economics, urban systems planning, as well as that of Food Service and Housing Administration. In late

1973, funding became available for a literature search and planning study and work began in December of that year. The present volume is one outcome of that study.

A second outcome of our work is the design for a second phase which will be implemented beginning July 1, 1974, to construct "scenarios" of the future world of food service--realistic explorations of the effects of reasonably foreseeable changes.*

In this second phase of the study, a base will be provided for considering issues such as what kind of food service industry is likely by 1985? What kinds of jobs will such an industry offer? What knowledge and skills will those jobs require? Which parts of the knowledge and skill base can best be addressed by education? Ultimately, then, our product should not be a curriculum made up of the traditional "pieces" of food service education but a reasoned basis for planning vocational technical curricula of the future. The real clientele of the study--freshmen entering high school in 1976 (and thereafter)--will not have reached their 25th year by 1985 and will still be trusty "under 30's" by 1990.

The present work is not basically about the future; it is a study of the present (which will serve, however, as the basis of the subsequent effort to consider the future). The purpose of the study is to map the economic and technological territory of the industry; to identify the dynamics shaping the industry today; and, to separate out from the many useful questions researchers might find of interest those which are crucial to an orderly consideration of the future.

---

* For a discussion of the use of "scenarios" in considering the future and a useful, popular exposition of some of the problems and pitfalls of long range forecasting, see Kahn and Weiner's The Year 2000.

Food Science and Engineering

As Professor Joseph MacNeil makes clear in the section on food science and technology, the potential for change within the existing technology is enormous. A picture emerges of a technology that is past basic, ground breaking research and moving at an accelerating pace into highly specialized applications. Specialized, high volume systems directed at a particular (food) raw material or group of food products are coming into their own, increasing the volume of individual products available, thus reducing costs through economies of scale. Difficulties of processing particular products are being overcome and increasingly the final product is a combination of products which, themselves, are already highly processed by the time they reach the final processing steps.

A principal research interest of Professor Frank Schmidt is heat transfer, a subject which includes topics such as cooking, freezing and cooking viewed from an engineering standpoint. While significant advances appear to be at the point of adoption or in the offing in the use of radar ranges and heat pipes, no basic technological breakthroughs are expected in heat transfer technology, Interestingly, the major change he sees in equipment does not represent so much a technological change as a systemic change resulting from equipment systems with a capacity enormously greater than even a large kitchen and offering substantial labor economies. These new systems, however, are able to operate economically at much lower levels of output capacity than the typical frozen food manufacturing plant, thus offering substantially greater flexibility in the line of frozen (or chilled) prepared products available.

As Schmidt points out, the communication problems between scientists, engineers, equipment manufacturers, and food service managers retard the work of all. Development of a common vocabulary, a recognition of the valid point of view of the others within this group, and an understanding of their problems would be highly desirable. One likely side effect of the present work is the development of concrete efforts at this University to encourage such intercommunication.

A significant point which emerges from a consideration of the sections on Food Science and Engineering, which is confirmed by field observation, is that any product or process innovation that benefits the independent also benefits the larger institutional operation. Many of the most recent developments in equipment do offer unique advantages to large-scale food service operations--and operations that learn to use large-scale food production in commissaries and other mass feeding contexts. A visit by project staff to the National Restaurant Exposition revealed a number of new, large-scale food production systems, but only one new piece of equipment which was usable by the individual restaurant (a steam convection cooker).

Since consumers' views of restaurant prices are shaped by the price of alternate services, the availability of economies of scale in large-scale food production facilities, and the consequent ability of such operations to pass on savings to the guest, may well lead the guest to make unfavorable price comparisons when dining in restaurants unable to achieve such economies. One way in which some economies are being achieved in chain restaurants is through commissaries. The time may have come when food wholesalers offer the "commissary function" in a broad and varied prepared product line, individualized to local tastes. The "Neff" system discussed by Schmidt certainly appears to offer advantages to those who can use such large-scale food production systems as commissaries.

Nutrition and Food Service

Professor Barbara Shannon's study of Nutrition as a factor affecting food service is especially timely. The effects of consumerism can be seen in many industries, but that force has not yet begun to affect the food service field seriously. As an industry, we still have time to act without pressure but nutrition will certainly affect the industry's future, particularly in such a rapidly growing area of public sector feeding as school lunch and congregate feeding for the aging.

Professor Shannon's study reveals important, but currently neglected areas for research. The effect of the food service establishment's production system (reconstitution and holding of product) on nutritional values has not been adequately studied nor has there been definite work on nutrition retention in frozen prepared food. Since institutional feeding is increasing rapidly and the use of frozen prepared food is accelerating in all food service settings, a clear understanding of the nutritional issues related to the two interacting areas of concern is called for. Consumerists, once aroused by an irresponsible (even if unintentional) rendering of services, generate pressures that are difficult and expensive to deal with. We may hope that the research necessary to identify the relevant issues will be forthcoming. It seems likely that an essential part of the food service worker's knowledge base in a future, increasing consumerist world will include an understanding of the handling of products for maximum nutrition retention, particularly in mass feeding where 30 percent or more of the guest's nutritional intake is controlled by the establishment.

Urban Systems

Professor Eugene Bazan explores the effects of demography and migration on the demand for food service, pointing to the importance of increasing suburbanization. He reviews the effect of life style and income changes on the restaurant industry economic structure and the industry's response particularly franchising, in meeting this demand. These concerns are viewed in a context of changing transportation which, in turn, affects not only demand but the physical distribution systems which serve the food service industry. While the techniques Professor Bazan employs in his essay are already well-known to social scientists, they have not been widely applied in the area of food service. The implications of Dr. Bazan's contributions are, therefore, particularly interesting.

Economics and the Food Service Industry

Professor James Smith offers us a "map" of the food and beverage production and consumption system, tracing product from raw material to retail sale, showing the various sectors of food service as part of the retail establishment serving the guest.

This study shows, too, developments over time in the amount of value added by labor in the various segments of the system, and it reviews the Bureau of Labor Statistics Employment Model (which may, in part, serve as a basis for the continuation of the present work). In reviewing the material on value added, it is interesting to note the growth in four years in the amount of labor added in food service establishments of from just under 20 percent to approximately 24 percent--an increase in proportion which is, itself, 20 percent. Statistics presented by Smith offer, in addition, support for the notion (which MacNeil has developed from another point of view) that the amount of value added to the product in manufacturing finally purchased by the retail sector for subsequent resale to the consumer has increased significantly.

Smith's summary of the patterns of food consumption of families of different sizes and different incomes offer encouragement to the food service industry. Smaller families spent nearly as much on food away from home as larger families, and there is a substantial increase in food consumption away from home as income increases. In a time of increasing incomes and smaller families, this empirical evidence of consumer behavior suggests strong continued demand for the output of the food service industry. An important point that emerges from the statistics on the industry as a whole is the very rapid growth of the institutional market.

Industry Dynamics

In the section of this report on industry dynamics, a principal focus of concern is on labor cost and supply and on the productivity of labor. Finally, a bibliographic essay sketches the dynamics of the industry as they are perceived today, principally (though not exclusively) by writers and publications outside the food service field.

Naive observation suggests that the average age of waiters and waitresses (servers) is increasing in fine dining establishments. The possibility that the number of young persons who have chosen or will choose a career as servers will be inadequate to meet the replacement needs of the restaurant industry led us to undertake a pilot study of probable labor supply trends with respect to servers. The time available was not sufficient to complete the analysis of this data by the publication date of this report. This "server study" will, therefore, be reported in a special addendum to this report.

Function of this Volume

In preparing this report, we have attempted not only to "tell what we learned" but to develop a basic document which might be useful to food service teachers and curriculum planners as well as a volume which might be of interest to the industry and to students. The detailed Table of Contents enables the reader to find those sections which cover his or her special interest. Considerable effort has been devoted, too, to indicating sources so that the reader interested in reviewing the topic further can go to the original article or articles for more detailed study. No pretence is made that this volume is a thriller; we hope it can be a useful reference document.

The contributors to this volume have used several recognized scholarly methods for collecting and citing existing information. We intentionally encouraged them to use the method both comfortable to them and useful for a reader interested in consulting original sources. In fact, one of the principal goals of this study was to acquaint a reader with the mountains of helpful literature that exist and to direct him, quickly and easily, to that material.

Therefore we offer this suggestion: If you intend to read this volume from cover to cover, from beginning to end, by all means proceed that way. If however, having consulted the Table of Contents, you find an essay that sounds particularly interesting, turn first to the bibliography that concludes that essay. If you are a food service educator, you will probably notice titles that sound as though they could complement a lecture, a classroom assignment, or even your own research. If you are a food service professional, you may find articles that can expedite your work--that is, save you time, effort, or expense.

Having scanned the biliography with care, next read the essay it helped shape. You will immediately see how the contributor has woven the main points of his source material into his essay. Like all bibliographical essays, these place the main points of the source materials into an overview context, narrative and sequential in tone. But in addition, they usually suggest in only a general way the more thorough treatment the subject matter received in its original context. The bibliographical essay imparts a good deal of general information; the source material that builds it typically treats specific material in far more detail.

I

INDUSTRY DYNAMICS:
AN INSTITUTIONAL VIEW

by

Thomas F. Powers, Ph.D.

INDUSTRY DYNAMICS:

AN INSTITUTIONAL VIEW

Labor Cost, Labor Supply and The Food Service Industry

Introduction

Labor is identified by economists as one of the three basic factors of production: land, labor and capital. It is clearly one of the most basic inputs to any kind of enterprise.* Labor costs of the food service and housing industries have undergone seemingly radical change in recent years and structural developments in the labor market suggest that the pattern of change will not only continue but accelerate. A number of factors have bid up the price of labor in recent years. Principal among these are a growing economy coupled with a relatively tight labor market; and, the social welfare policy of the state and national governments.

This section will review briefly historical trends in wage rates and in the minimum wage, examine new factors whose effect is only beginning to be felt from the social policy domain, and attempt to consider the probable impact of logical future developments on the work force and hence on food service and housing enterprises.

The Minimum Wage

Toward the end of the Great Depression of the 30's, the Fair

---

*This discussion has been adapted from one that appeared in The Cornell Hotel and Restaurant Administration Quarterly (May, 1975), pp. 5-13.

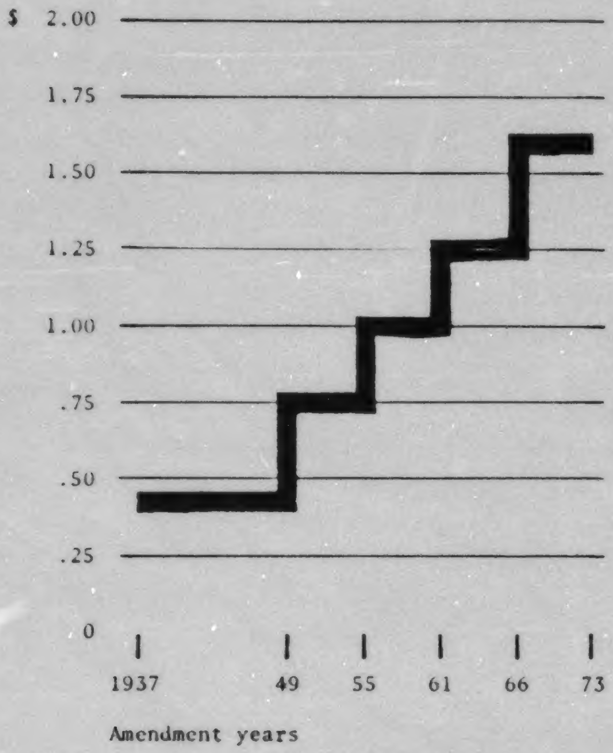
Labor Standards Act of 1938 was enacted. "The Goals of wage regulation were: 1)elimination of poverty resulting from substandard wages; 2) creation of the necessary purchasing power to maintain high levels of employment and output; and 3) establishment of a floor under wages to prevent repetition of the downward wage spiral experienced during the depression."[1] The minimum wage established by that act was 40¢ an hour. After World War II the act was amended in 1949 raising the minimum wage to 75¢ an hour. Overtime penalty pay provisions were clarified and spelled out in considerable detail in this set of amendments. In 1955 the minimum wage was raised to $1.00 an hour and in 1961 the basic minimum wage was raised to $1.25.

The general trend, which is summarized in Figure 1, was clearly one of raising wages. During the same time, legislation was passed broadening the coverage to include more industries and to include smaller firms. These tendencies reached the hospitality industries in 1966, when the national minimum wage was raised to $1.60 an hour and food service and housing establishments were brought under FLSA regulation at $1.00 an hour with fifteen-cent raises each year to bring the industry's wage to the national level of $1.60 an hour by 1971.

The Rise in Earnings. As Figure 2 suggests, average hourly earnings have risen for hospitality industries, as have hourly earnings of other service employees and other retail employees and, indeed, as have wages for all employees. While the lines representing wages in these various groups are not perfectly parallel, an examination of the figures suggests that the rates of increase

Figure 1

Increases of Minimum Wage 1938 to 1973

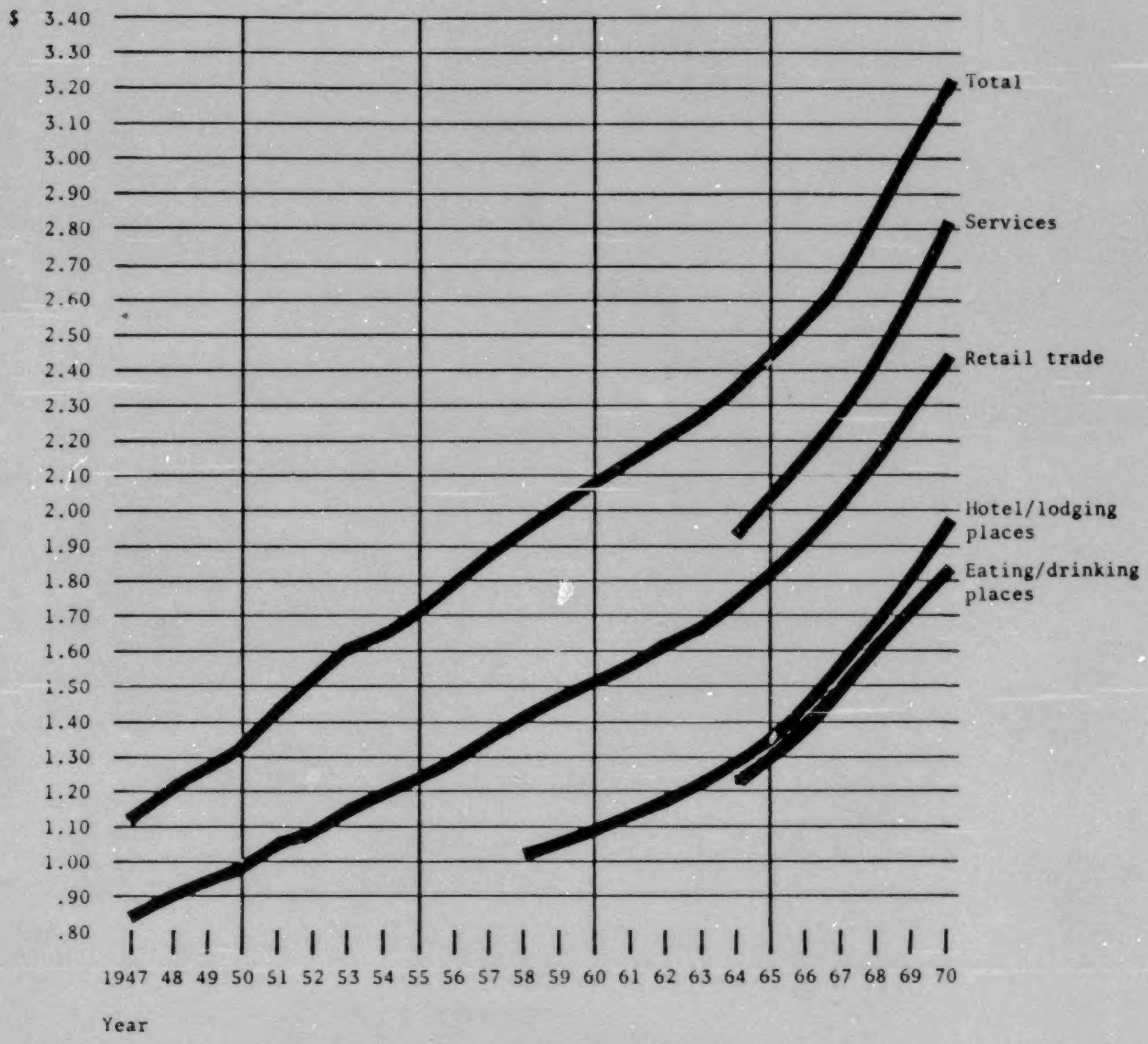


Source

Legislative Analysis: Proposed Minimum Wage Amendments, American Enterprise Institute for Public Policy Research (Wash., D.C.), Legislative Analysis #5, 93rd Congress, May 9, 1973.

Figure 2

Average Hourly Earnings of Production (Nonsupervisory) Workers on Nonagricultural Payrolls 1947 to 1970



Source

Employment and Earnings for the United States (1909-1971), Bureau of Labor Statistics, pp. 548 and 565.

experienced by our industries have not been radically different than those of other industries.

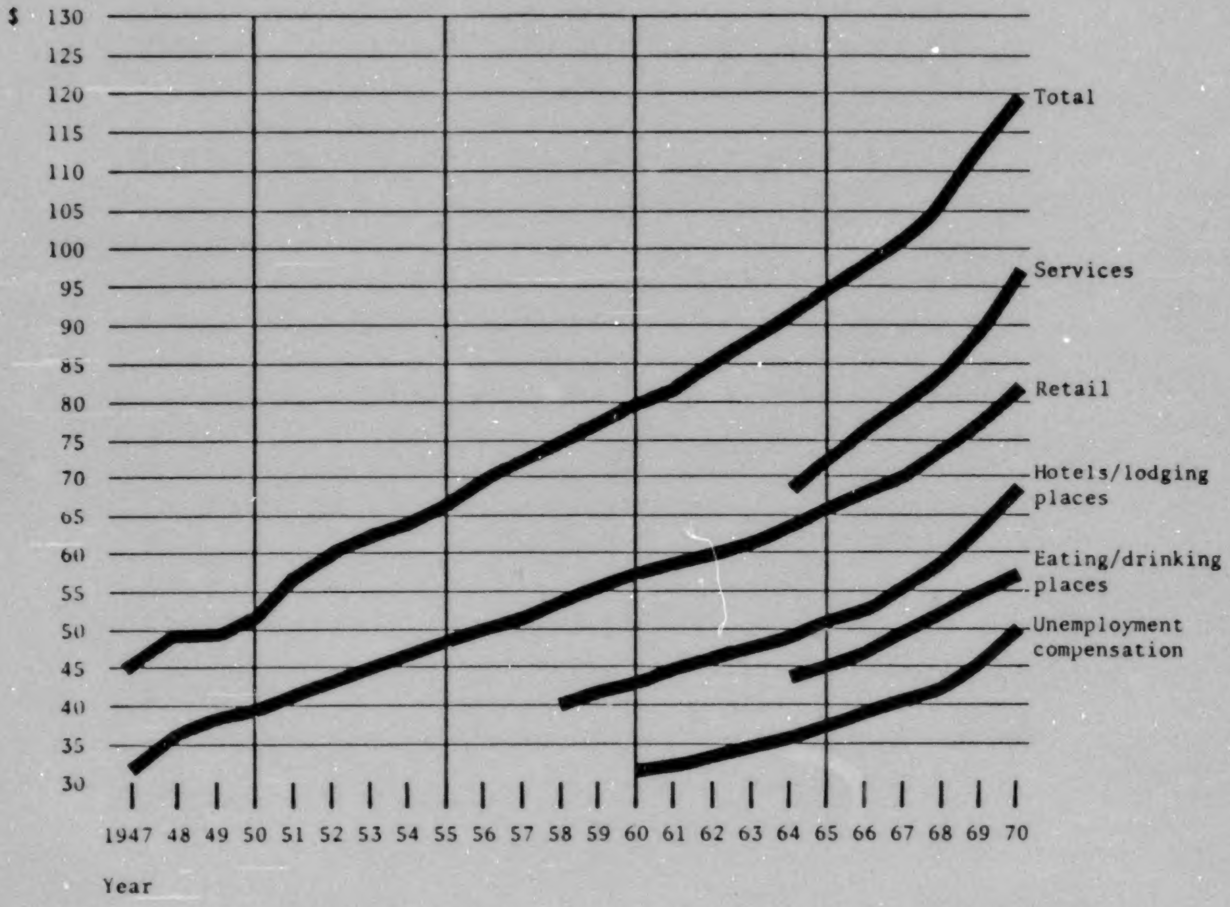
Figure 3, which reflects not only hourly income but also the length (i.e.g, number of hours) of the work week, suggests that hotel and food service employees' weekly earnings have risen at a rate similar to other employee groups. An interesting development shown in Figure 4 is that unemployment benefits (for all employees) begin to approach the rate of compensation for employees in the food service and housing industries.[2]

Although wages have risen rapidly in our industries, that increase has, in fact, been less rapid than the rise of wages in the economy in general. Hotel wages rose 70 percent from 1958 to 1970, while wages for the whole economy rose 80 percent. Food service wages rose 30 percent from 1964 (the earliest year for which this data is available) to 1970. In the same period, wages for all employees rose 43 percent. On the other hand, the rise in wages in the economy as a whole was accompanied by an increase in productivity. Output per man hour in the United States rose 12 percent from 1964 to 1970 and 35 percent from 1958 to 1970. Unit labor costs for the entire economy rose 27 percent from 1964 to 1970, and 34 percent from 1958 to 1970. The relationship between output per man hour, unit labor costs, and compensation in the total economy is compared with wage data for hospitality industries in Figure 4.

The Plateau in Productivity. Although no separate productivity index is available for food service and housing industries, it is important to notice that the majority of the workers in our industries

Figure 3

Average Weekly Earnings of Production (Nonsupervisory) Workers on Private Nonagricultural Payrolls 1947 to 1970

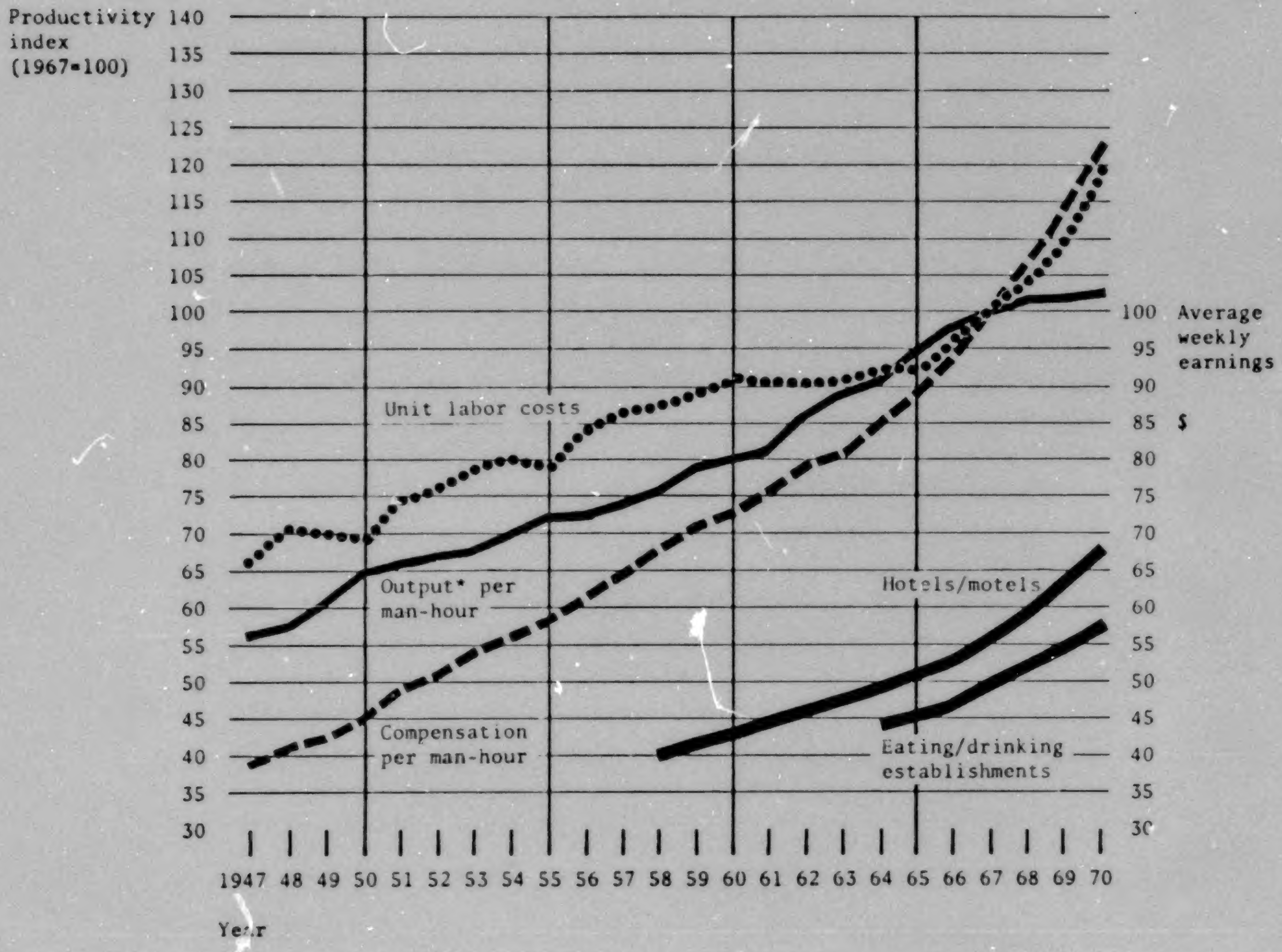


Source

Employment and Earnings for the United States (1909-1971), Bureau of Labor Statistics, pp. 548 and 565.

Figure 4

Average Weekly Earnings of Food/Drink Establishments and Hotels/Motels Compared to Indices of Economic Productivity 1947 to 1970



*Output refers to GNP in 1958 dollars

Sources

Productivity indices
Economic Report of the President, 1973; Annual Report of the Council of Economic Advisors, Table C-32, "Output per Man-hour and Related Data, Private Economy, 1947-72" (p. 230).

Average weekly earnings
Employment and Earnings for the United States (1909-1971), Bureau of Labor Statistics pp. 548 and 565.

are engaged in either personal service work or in manual occupations in which only limited productivity increases are available through mechanization. While wages for hospitality industries rose at a slightly slower pace than in the economy as a whole, it seems reasonable to assume that productivity in traditional hospitality firms such as hotels and restaurants rose only marginally.

Some increases in productivity might be noted, for instance in the trend toward more self service (for instance in the use of buffets, reduction in bell staff services) and limited economies may have been realized from such automated devices as dial switchboards. The basic picture, however, remains one of a labor intensive, personal service industry. If this reasoning is correct, it follows that unit labor costs (i.e., the portion of revenue from each cover sold or room rented required to cover labor costs) in the hospitality industries have risen at a substantially higher rate than they have in the economy as a whole.

It is instructive to look at the firms in our industries which have improved productivity. In fast food, where the number of covers served per employee is surely radically higher than in the more traditional restaurant setting, what we have is not so much the introduction of automated equipment as the complete redesign of the food service system relying on a drastically simplified menu and self-service,[3] as well as the introduction of industrial engineering techniques accompanied by a certain amount of automation.[4]

As wages rise (along with other costs) the operator has really only two choices, aside from going out of business. Those are either to rework the system to eliminate labor (as in fast food, perhaps, by drastically simplifying the system) or to incorporate the ever higher cost stricture in the price offered to the consumer and maintain the traditional level of service. As prices in traditional service settings rise, that increased price structure offers an inducement to innovators to develop new, simplified formats, such as the fast food operations have done, to compete on a price basis with the traditional establishment.

Social Policy and Labor Supply

Writing in 1965 on the labor market of the lodging industries, John P. Henderson stated:

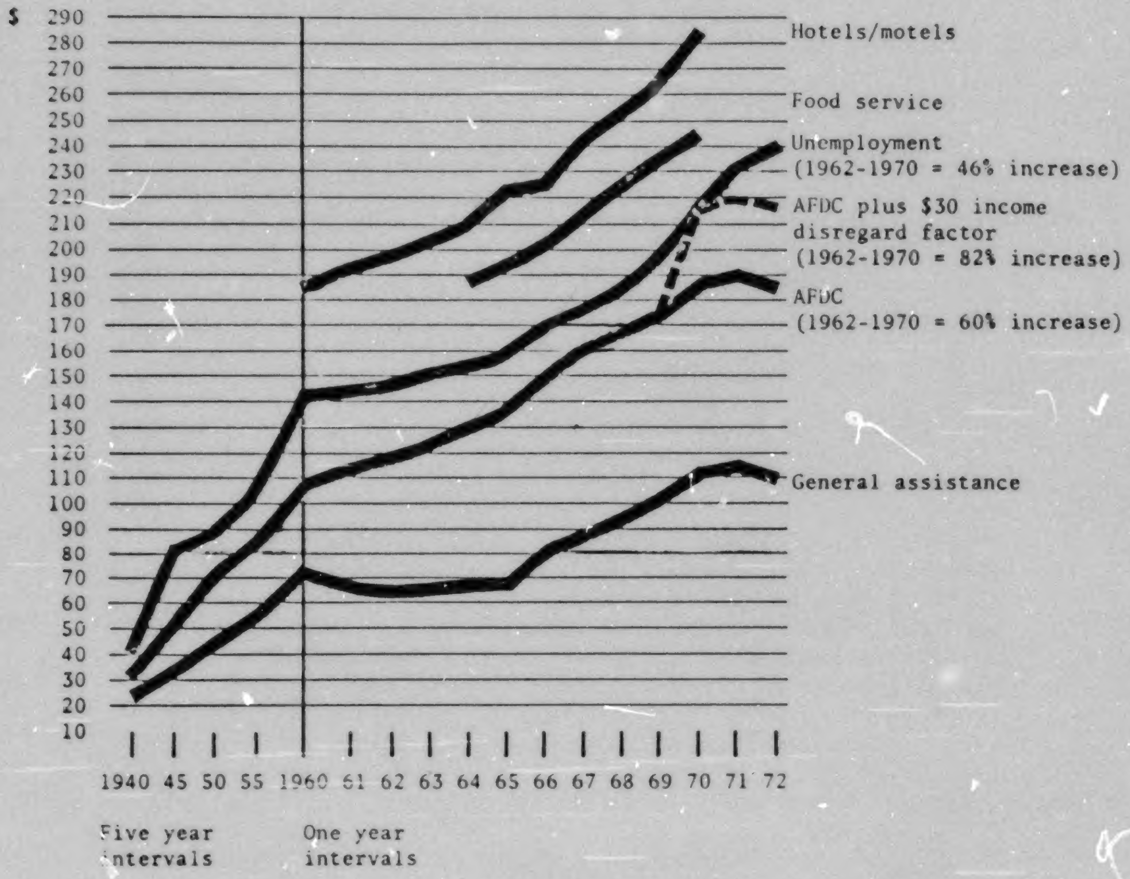
> But for the unskilled 50 to 60 percent of workers at the base of the lodging industry pyramid, there are few alternatives, and these workers do not have much opportunity to move into new occupations and industries. It is this lack of mobility that has allowed the industry to continue to pay such low wages to many employees, since it is obvious there has been no need to offer higher wages to attract the requisite number of workers.[5]

This condition, so recently described by Professor Henderson, may, in fact, be changing radically at the present time. Figure 5 compares wages in the food service and housing industry to incomes available for "non work." While general assistance has never been competitive with wage earnings, patterns set by AFDC (Aid for Dependent Children) are clearly on the verge of being competitive with the wage scale of our industry.

Work vs. Welfare. In evaluating Figure 5 it is important to realize that the hotel or restaurant worker of interest is not the tipped worker but the 50 to 60 percent Henderson referred to as

Figure 5

Average Monthly Benefits: AFDC, General Assistance and Unemployment* Compared to Average Monthly Wages* for Food Service and Hotel/Motel Establishments



Notes

*Wages and unemployment data represented by weekly amount x (4.3)

General assistance and AFDC benefits per family

Wages and unemployment per individual

Welfare benefits measure cash benefits only--does not include other services such as counselling, medical services, food stamps and non-recurring grants such as special allowances for winter clothing or furniture

---

Sources

Food service and hotel/motel establishments
Employment and Earnings for the United States (1909-1971), Bureau of Labor Statistics, pp. 548 and 565.

AFDC, general assistance and unemployment benefits
Current Operating Statistics in the *Social Security Bulletin*, Dec. 1972

unskilled. Thus, understatement of tipped income is not a factor in the comparison. On the other hand, it is perhaps even more important to notice that the welfare benefits shown in Figure 5 are probably a significant understatement of the actual benefits available. In addition to the dollar income received from AFDC, generally included in those benefits are free medical care, food stamps (and free lunch for school children), and substantial free counseling services on economic, family, and social matters. As one authority has put it, "it is worth pointing out here that a job at the minimum wage level in New York City yields an equivalent annual income significantly lower than the scheduled welfare budget allowance for a family of four."[6]

Table 1

Changes in Average Minimum Wage and Non-Wage Incomes in New York State

1962-67	Increase
Average Wage	13%
Minimum Wage	30%
Welfare Allowance*	40%

*Average of all welfare programs
Source: Durbin, Welfare Income and Employment

Table 2

Changes in AFDC Payments, Benefits and Recipients in New York State

1965-70	Increase
AFDC Expenditures	156%
Increased Benefits	52%
Increased Number of Recipients	48%

Source: Durbin, Welfare Income and Employment.

Welfare benefits, as Figure 5 indicates, have increased dramatically in the past thirty years. Durbin, in a study of welfare benefits in New York states that "welfare benefits increased more than average wages in manufacturing, more than the minimum wage and more than the average or maximum unemployment compensation benefits."[7] Between 1962 and 1967 Durbin's study shows average wages rose 13 percent while the minimum wage rose 30 percent and the welfare allowance rose 40 percent. AFDC expenditures have grown 156 percent between 1965 and 1970. This growth was attributed to increased benefits (52 percent) and increased number of recipients (48 percent). These rates of change are summarized in Tables 1 and 2.

Another point to recall in gauging the understatement of the welfare benefit is suggested by the dotted line in Figure 5 which begins in 1969 for AFDC, referred to as the "income disregard factor." Beginning in that year the first $30 of earned income (and a declining portion of all income over that amount) was disregarded in computing welfare benefits. While the intent of this is to encourage employment on the part of individuals on welfare, it may have the additional effect of making welfare more attractive, since a person can work about one day a week in some kind of part-time job without any welfare reduction. Moreover, case workers commonly ignore sporadic, non-recurring earned income, and many welfare recipients engage in baby sitting and a wide variety of other activities that are convenient for their status in life and which are difficult for welfare departments to establish as bonified employment for purposes of reducing welfare payments.

The most generous benefits for non-work are found in AFDC, and

AFDC is certainly the fastest growing form of welfare. These benefits are generally (though not exclusively) supplied to female heads of household. Thus it might be thought that the effect of this policy is to reduce the number of women in the work force. In practice, however, welfare benefits have the effect of reducing work force participation by adult male and teenage children.[8]

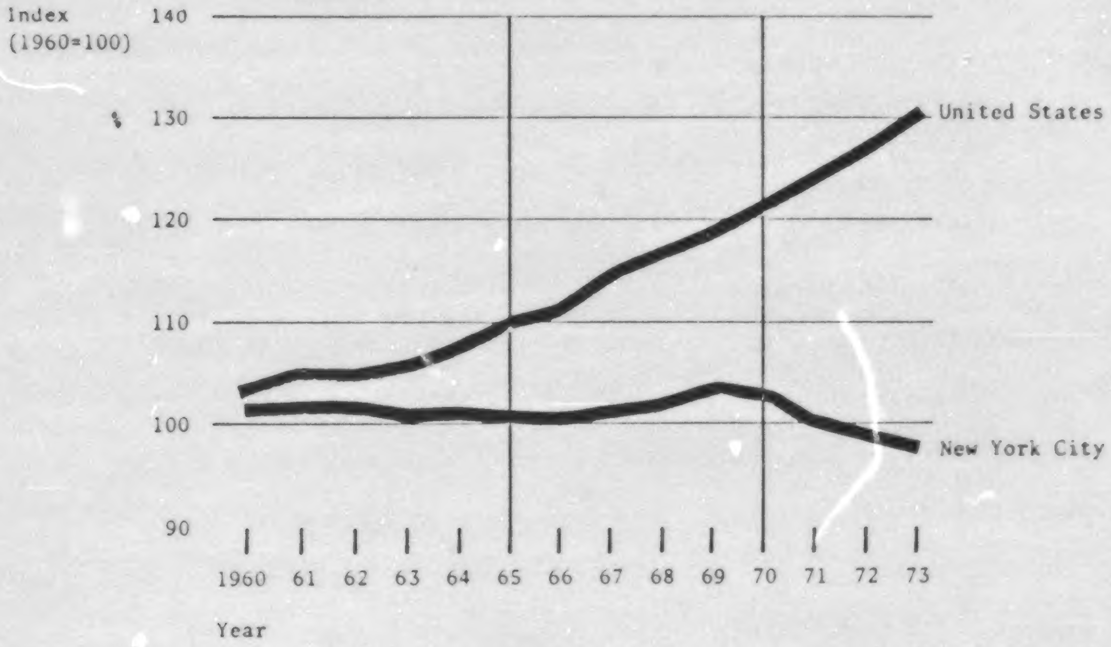
A recent study by the Economics Department of the First National City Bank of New York discussed changes in work force size in New York City. Figure 6 shows a comparison of work force trends in New York City with national trends. The reduction in New York's force is accounted for by two factors, a stable level of population and a decline in labor force participation contrasted with a rising national participation rate. The logical speculation which arises out of this bank's study is that the reduction in work force participation is in large part due to welfare alternatives. The reduction in the work force is "centered in, although not limited to, the younger segment of minority, female workers."[9] This, quite obviously, is also a reasonable description of much of the clientele of AFDC.

Where Are We?

At this point, it is clear that for many years our industries have been subject to the pressure of rising wage rates. As wage cost has increased, either productivity was increased to offset some or all of that cost by redesigning the system, using ever simpler food service systems as in fast food, or the price structure of the

Figure 6

Work Force Size: New York City Compared to United States



Note

The U.S. index refers to the civilian labor force as reported by households in the Current Population Survey. The New York City index refers to the work force based on reports by business establishments to New York State Labor Dept. and on unemployment compensation data.

Source

Economics Department, First National City Bank establishment was changed to pass on to the consumer the increase in the cost of the factors of production.

The rising price of the products and services of the traditional hotel and restaurant industries has provided an inducement to innovators to design still more systems which were of lower cost to operate and hence could be provided to the consumer under the umbrella of the price structure of traditional establishments.

A developing trend, however, in social policy is the growth of various welfare incomes to the point where they generally approach and commonly exceed the incomes of those working at the lower end of the wage scale. It should be noted that these benefits do not apply to all workers, nor do they apply all the time. As a general rule, AFDC benefits are limited to women who are heads of households, while unemployment is available only for a period of time (an average of 26 weeks) following on some employment and thus cannot be pursued as a way of life permanently. On the other hand, the rising level of the general welfare benefit, more generous standards in the granting of food stamp benefits, and the constant pressure to raise the floor of general assistance suggest that the standards now set by AFDC may emerge as the set of standards to be applied to a broader group of welfare recipients within the foreseeable future.

At least two effects can be anticipated from an increasingly generous welfare policy. One of these is to establish an income floor for all workers that may be more significant than the minimum wage. Clearly, if an employee can make more money by not working than by working, the employee is likely to engage in a rational choice based on economic considerations and choose the more remunerative "non-work" over work. Moreover, many observers of the food service and housing industries have noted that there is little in the way of intrinsic reward to be had from our industry's unskilled jobs. As Durbin has pointed out, "if working had positive value in addition to the goods and services purchaseable, the person would not have to be paid so much to give up his leisure; but, obviously, if work is actually so distasteful that it has a negative value, even more has to be paid."[10]

A second probable impact is that today's welfare benefits offer a choice between work and non-work to ever larger number of employees. Thus, a person who shrinks from the stigma of being a welfare recipient may nevertheless choose that role. If she is a mother for instance, she may think that stigma less important than her desire and need to be with her children. In some subcultures, of course, the presence of any stigma at all is open to question. Thus we have not only the effect of a wage floor but, increasingly, of withdrawal from the work force by unskilled workers with a resulting labor "shortage" at the lower end of the skills level scale.

Where Do We Go from Here?

If we face a pattern of still steeper wage cost increases coupled with even greater scarcity of unskilled and semi-skilled labor, what kind of consequences can we expect? Perhaps the most difficult point for many operators to accept is that serious, fundamental changes in the way we do business are in the offing. This is difficult to accept because the hospitality industries are and have been anchored in our own traditions. It took a Memphis real estate developer--Kemmons Wilson--to revolutionize the post-World War II lodging industry and a handful of inventive food service operators to develop the fast food concept.

Faced with innovative competition, a surprising number of operators have chosen to "stand and fight" on the lines of what they have seen to be their standards of service. While there is limited quantitative support for my position, it appears that the batting average of the traditional operator faced with innovative competition has not been particularly good over the past 25 years. A few outstanding operators have done very well. But the number of hotel rooms in operation declined from 1,550,000 in 1948 to 1,265,000 in 1972,[11] the countryside is littered with closed diners and family restaurants of an old model, and many prestigious "great" restaurants have experienced difficulty as well, often closing their doors.[12]

In the lodging industry, some of the difficulty may be attributable to the separation of the operator's knowledge of what must be done from the owner's decision-making power by the ignorance of many owners, informed as they are by a view of the lodging establishment as an investment without necessarily appreciating the operating realities which govern the long run success of that investment. Still, there are enough operators of a traditional cast of mind that they can hardly be excepted from a general statement regarding resistance to change.

If change is coming, what kinds of change may we expect? Some obvious changes in materials used are probably at hand as are major changes in the equipment to handle whatever processes are required by the work of the establishment. More fundamentally, change in what we think of as service is almost certain to occur. What follows should not be thought of as "solutions" but rather as some preliminary speculations on the likely directions of change.

Changed Materials. If labor becomes both scarcer and much more expensive, the market for prepared foods is likely to expand. In general, it seems reasonable to assume that the large food processors' economy of scale advantages will become more pronounced as the hospitality industry's wage scale rises. As is already the case to a degree, moreover, lack of availability of unskilled labor--as well as its high cost--will force operators to move further and further toward the ready end of the raw-to-ready scale in purchasing. This larger market may increase competition in that area, hopefully resulting in improved quality and variety, and possibly--with major volume increases--reduction in prices. It is premature to predict the development of the food service establishment into a service-intensive retail outlet for manufactured goods, but this may serve as an approximate description of direction for some segments of the industry.

The increased use of dispoable service seems virtually certain, particularly in the light of the improving quality of disposable ware. This development is, however, clearly bounded by environmental constraints, both as to scarcity of resources reflected in higher disposable ware prices and by disposal problems related to pollution. Increased concern with water quality may, however, operate to the disadvantage of permanent ware and hence to the advantage of disposables.

Changed Equipment. Equipment changes that were not economically feasible five years ago may well offer significant cost savings in the labor market of five years from now. If the move to manufactured foods referred to above takes place, however, the principal *on premise* food service equipment changes may be expected to be related to materials handling systems dealing with the way product is moved from receiving into storage, from storage to the preparation or reconstitution station, and thence to the server or guest.

Perhaps the most important development in equipment will be in the capabilities of the industry's suppliers. The computer operated, small-scale food preparation systems,[13] pioneered by European manufacturers, may make it quite possible that the structure of the prepared food manufacturing industry will change from one dominated by large companies to one in which company commissaries *and commissaries operated by institutional food wholesalers* serve a number of retail outlets in a relatively localized market.

Toward a New Concept of Service

If we are to think about serve in a constructive way in an age of exponential change in costs and availability of labor, we must change the set of questions we are asking in a fundamental way. We must shift from discussing what we are asking in a fundamental way. We must shift from discussing what we know to what we do not know. Discussions of service among industry people focus on alternations or reinforcements of traditional patterns of service and traditional service roles: "Bellmen carry bags and waitresses serve food. How can we change those processes to do them better or at lower cost?" These questions concentrate on what we know something about, but, from a systems analytic view, they begin at the wrong end of the process. Our question must become, "What satisfaction does the guest require in this process and how can we, without regard to traditional patterns, offer that satisfaction to the guest at a cost that is realistic. More simply, what is our objective, stated in terms of the guest's needs and wants?" This shift in orientation disposes of a lot of mental baggage but since the baggage, for most of us, is a lifetime of experience, it is hard to let go.

Jerome Vallen in his recent article, "Service: A New Definition,"[14] stated the dilemma in economic terms. To paraphrase his point, it is an economic axiom that when the marginal utility (Satisfaction) per dollar is less for one good than for another, the consumer shifts his expenditures to the good with the higher economic utility per dollar. This is what has happened with service. With no real change in the absolute utility provided by personal service, the utility relative to non-service goods has dropped because of the failure of the hospitality industry to increase its productivity at the same pace as other industries.

While much of the evolution in service may be de-personalizing, it is equally possible that mechanization may make possible the "Re-personalization" of some service processes by eliminating time-consuming hand labor. We may be able to move from "rooming the guest" as a physical process to "greeting the guest" in a way the guest perceives as satisfying, for instance. The key is in a shift from thinking of the traditional process to concentrating on the needs and wants of the guest as the starting point in our reasoning. It is clear that both labor cost and labor supply constraints are making impossible the delivery of traditional services in more and more operations. Rather than "whittle away" at the quality of service, it may be time to begin a basic redefinition of the process.

Notes

[1] John P. Henderson, Labor Market Institutions and Wages in the Lodging Industry, MSU Business Studies, 1965, Division of Research, Bureau of Business and Economic Research, Graduate School of Business Administration, Michigan State University, East Lansing, Michigan, p. 100.

[2] Social Security Bulletin, "Current Operating Statistics," December, 1972, p. 60. Unemployment benefits for many hotel and restaurant workers might be somewhat less than the average shown for all workers because in most states unemployment benefits have some relationship to the income of the worker when employed. Since employees in hotels and restaurants earn less, their employment benefit would probably be at the lower end of the range. On the other hand, average earnings shown in Figures 2 and 3 do not include tip income. Since something on the order of 15 to 20 percent of hotel and restaurant employees are tipped employees, the average income of hotel and restaurant workers may be somewhat understated.

[3] Thomas F. Powers, "The Only Constant," Institutions Magazine, January, 1972, p. 34.

[4] Theodore Levitt, "Production Line Approach to Service," Harvard Business Review, September-October 1972, p. 41.

[5] Henderson, op. cit., p. 55.

[6] Elizabeth F. Durbin, Welfare Income and Employment: An Economic Analysis of Family Choice, 1969, Praeger, 1969, p. 13-14.

[7] Durbin, op. cit., p. 82.

[8] Durbin, op. cit., pp. 13-19. For an interesting and current anecdotal description of the process by which AFDC affects male and teenage withdrawal from the work force, see Gary Hoeniz, "Turf," New York Times Magazine, Nov. 4, 1973, p. 73.

[9] Why are New Yorkers Dropp-ng Out?," Monthly Economic Letter, Economics Department, First National City Bank, August, 1973, p. 13.

[10] Durbin, op. cit., p. 11.

[11] Trends in the Hotel/Motel Business, 1973, Harris Kerr Forster & Co., p. 3.

[12] See, for instance, Bujarski, Pamela, "The Haute Cuisine Restaurants Here Up Against The Kitchen Wall," New York Times Magazine, February 20, 1972, p. 10.

[13] Werner Sell, "New Equipment and Systems in Mass Feeding," Journal of the American Dietetic Association, October, 1973, p. 413.

[14] Jerome J. Vallen, "Service: A New Definition," The Institute Journal, East Lansing: The American Hotel/Motel Educational Institute, December, 1972, p. 8.

The Impact of Productivity on the Service Restaurant

The market for the food service, it is widely accepted, is enhanced by increasing incomes, rising education levels and an increasingly widely traveled public. Evidence of a basic interest in fine foods is supplied by the substantial audiences attracted to television programs related to haute cuisine such as that of Julia Childs and "the Galloping Gourmet," as well as by the growing circulation of magazines such as Gourmet and a substantial increase in sales of wide varieties of cook books.

Service restaurants, however, must compete with alternate leisure and recreation choices. Equally importantly, the food service industry's ability to satisfy demand is basically a function of changing costs of the factors of production and of an emerging technology. The balance of this article explores data on productivity in various kinds of food service establishments and infers, from the change in the mix of restaurant types in operation since 1960, the direction in which the industry is moving. Finally, the potential impact of large quantity food production systems will be assessed as laying the ground for a move toward greater variety in food selection.

My particular concern is with the service restaurant. It will be appropriate to divide those in turn into two general groups, the luxury restaurant and the family restaurant. A separate kind of service system is found in cafeterias which are generally competitive with the family restaurant. Table 1 presents an operating profile developed by

Freshwater of 25 food service operations from data gathered in 1968 for cafeterias and in 1969 for restaurants. Six single line and six double line cafeterias, six family restaurants and seven luxury restaurants were reviewed.[1,2]

As Table 1 indicates, the double line cafeterias differed from the family restaurants and single line cafeterias in being larger operations. All three economy operations, however, have roughly comparable check averages. Their food cost ranges between 35 percent and 38 percent, their payroll costs between 30 percent and 34 percent of sales.[2] The family restaurant, with a chair turn of 8.6 appears to make a more productive use of its physical facilities but, once again, in comparison with a chair turn of approximately five for cafeterias, there is a rough similarity in result.

These three economy style food service operations can be contrasted with the luxury restaurant whose dollar sales exceed those of the smaller economy food service establishments. This dollar volume is attained, however, with a much smaller number of guests--roughly one-third the number of guests served in the single line cafeteria or family restaurant. Clearly this result is achieved because of the higher selling price with a check average of approximately five times that experienced in the economy operations (not check average in 1969). On the other hand, the food cost lies within the approximate range of the economy establishment (at the upper end) while the payroll lies at the lower end of the scale for the other operations.

In choosing these operations, Freshwater and his colleagues specifically chose representatives of successful operations within each field. Clearly, then, these operations are not representative of all

TABLE 1

Operating Profile of 25 Food Service Operations

	Single Line Cafeterias[a]	Double Line Cafeterias[a]	Family Type Restaurant[a]	Luxury Restaurant[b]
Estimated Annual Sales	$ 525,000	$ 872,000	$ 563,500	$ 702,200[c]
Average Daily Guest Count	1,260	2,136	1,290	381
Check Average	$ 1.22	$ 1.20	$ 1.34	$ 6.26
Food Cost % of Sales	38%	36%	35%	39%
Payroll % of Sales	30%	34%	32%	29%
Chair Turn/day	5.2	5.0	8.6	1.4

---

[a] Average of Six Studied

[b] Average of Seven Studied

[c] Generally Lunch and Dinner only Served

Source: Agricultural Research Service

TABLE 2

Ratio of Productive Man Hours to Total Man Hours[c]

	Performance
Single Line Cafeterias[a]	81.2
Double Line Cafeterias[a]	70.0
Family Type Restaurants[a]	77.9
Occasion Type Restaurants[b]	73.9

---

[a] Average of Six Studied

[b] Average of Seven Studied

[c] Based on Work Sampling

Source: Agricultural Research Service

Table 1 actually understates the labor cost in service restaurants because it ignores tips paid by the guest directly to employees. If we assume no tips are given in cafeterias and a tip of 15 percent of the average tip is given in Family Type and Luxury restaurants and add that amount to both sales and payroll cost, a significant change in relative cost patterns results which is summarized below:

Table 1a

Establishment Type	Check Average without tip	Check average with tip	Wage bill without tip	Payroll % without tip	Wage bill with tip	Payroll % with tip
Single Line Cafeteria	$1.22	$1.22	.37	30%	.37	30%
Double Line Cafeteria	1.20	1.20	.41	34	.41	34
Family Type Restaurant	1.34	1.54	.43	32	.63	40
Luxury Restaurant	6.26	7.20	1.81	29	2.75	38

restaurants but rather represent relatively successful versions of these styles of operations.

Freshwater's studies focused on the ration of productive man hours to total man hours. Table 2 shows that the luxury restaurant had a productivity performance that is well within the range of the productivity of the economy style operations. Turning to Table 3, we begin to see drastic differences between the economy type restaurant and the luxury operation. Very clearly the labor requirements, across the board, are much more intensive for the luxury operation. The time consumed per hundred guests for cooking the more elaborate dishes in the luxury restaurant occupy something on the order of three times that of the more economical restaurant. The same is true for the salad department and for warewashing. Personal communication with Mr. Freshwater confirms the supposition raised by Table 2, namely that these variations in man-hour requirements are the result of more complex service and not of some lower efficiency that was not accounted for in the statistics. There is simply more silverware, more china and other utensils used in dining in this style restaurant than there is in the less elaborate economy class. Consequently, there is more work generated per guest in warewashing just as salads and cooked foods require more attention and man hours in this style of operation.

Similarly, in customer service it is possible to make rough comparisons between the family type restaurant and the cafeterias if serving and utility, and bus and tray labor in cafeterias are added together. (This does involve some inaccuracy since part of the work done by serving personnel in a cafeteria might be accounted for by pantry personnel in a conventional restaurant.) Cafeterias require

TABLE 3

Summary of Manhour Requirements for 25 Food Service Operations

	Man hours per hundred guests required by			
	Single Line Cafeterias[a]	Double Line Cafeterias[a]	Family Type Restaurants[a]	Luxury Restaurants[b]
Meat and Vegetable	3.30	2.90	3.85	13.89
Salad	1.20	1.02	1.44	5.23
Ware washing	3.10	2.86	3.47	11.75
Customer service	--	--	12.10	35.75
Serving & Utility	5.75	6.83	--	--
Bus & Tray	3.19	3.78	--	--
Bar	--	--	--	5.69
Bakery	1.85	.96	--	--
Total Direct Labor	18.39	18.35	20.86	72.31

---

[a] Average of Six Studied

[b] Average of Seven Studied

Source: Agricultural Research Service

TABLE 4

Productivity in Food Service Establishments

Food Service Type	Direct Labor Man Hours per Hundred Guests
Luxury Restaurants[a]	72.3
Family Restaurants[b]	20.7
Cafeterias[c]	18.3
Fast Food[d]	10.5

---

[a] Average of Seven Studied

[b] Average of Six Studied

[c] Average of Twelve Studied

[d] Average of Twelve Studied

Source: Agricultural Research Service

between 9 and 10 1/2 hours per hundred customers for service computed in this fashion compared with about 12 hours in a family type restaurant. The luxury restaurant requires nearly three times that amount of labor for serving or nearly 36 hours per hundred guests. Ignoring the amount of time required for bar operations, the luxury restaurant still requires well in excess of three times as many man hours per hundred guests as do any of the economy operations studied.

Table 4 presents summary data for the whole spectrum of food service operations including preliminary data supplied by Freshwater on Fast Food operations. As that data indicates, the fast food establishment with its extremely simple operating format requires half as many man hours per guest served as the family restaurant and one-seventh that of the luxury restaurant.[3]

The data that are presently available measuring changes, over time, in productivity in food service establishments, is unsatisfactory for any precise statement because of the large number of establishments with "no paid employees" (ie., operated by the owner and his family) which report sales but no wages, thus distorting the relationship of wages to output by seriously understating the industry's total wage bill. The information available, however, supports the general conclusion of a zero change in productivity over the past ten years. The rate of sales per employee for the food service industry is the lowest in the United States economy.[4] This assertion is based on data for the entire industry. Since there has been a very substantial increase in the number of fast food establishments in that 10-year period and these are known to be more highly productive, there is a reasonable presumption of an actual reduction in productivity since 1960 in the balance of the (non fast food) restaurant industry. While wages have not risen any more rapidly in the food service industries than in other sectors of the economy,[5] a zero productivity change compared with an average annual productivity change on the order of 4 percent in the rest of the economy builds a strong inflationary trend into the cost structure of the restaurant industry.

This strong inflationary bias appears to fall especially heavily on the luxury restaurant. Prices over a six year span at New York's very top restaurants rose approximately seventy percent. "On a broader sampling, at seventy of New York's finest restaurants the increase has amounted to perhaps 50 percent in six years."[6] Since this study was published in early 1972 it does not take into account the recent steep price rises based on food cost changes and is largely the result of rising labor costs only.

Fine dining establishments of pre-World War II featured a labor intensity that is hardly available in the United States today. The old Ritz Carlton had a kitchen staff of 60 including five sauciers, with a waiter and waiter's assistant for every two tables and a captain of waiters for every four tables to assure perfection in service. The price of a typical meal in that establishment was $3.50.[7] Since that time, the size of kitchens has been drastically reduced even in the finest restaurants and in the vast majority of restaurants the number of choices available to the guests have been very drastically reduced. Recent trends in industry composition may shed some light on how fine dining establishment will fare as we move into the future.

Table 5 demonstrates that there has been a fairly limited growth in the total number of restaurants since 1960. This growth is more

TABLE 5

Change in Number of Firms, United States Restuarant Industry 1960-1969

	1960	1969	Change
Restaurant and Specialty Food Units	247,000	254,000	+ 7,000
Fast Food Units	16,000	37,900	+ 11,900
Restaurants Other Than Fast Food	231,000	216,000	- 15,000
Fast Food Units % of Total Units	6.6%	14.9%	

Source: Economic Effects of Franchising

TABLE 6

Change in Number of Firms, United States Restaurant Industry, 1960-1971 Estimated

	1960	1971	Change
Restaurant and Specialty Food Units	247,000	256,000*	+ 9,000
Fast Food Units	16,000	46,200*	+ 30,200
Restaurants Other Than Fast Food	231,000	209,800	- 21,200
Fast Food Units of Total Units	6.6%	18.0%	

Sources: Economic Effects of Franchising

*The Specialty Restaurant Industry
Hayden Stone, Inc.

than accounted for by the increase in the number of fast food units. The latest period for which definitive figures are available is 1969. From 1960 to 1969 there was an increase of only 7,000 restaurant operations in total while there was an increase of 21,500 fast food establishments, clearly indicating that the number of non fast food restaurants has actually declined from 1960 to 1969.[8] Table 6 presents somewhat more provisional data based on an estimate provided by the security firm of Hayden Stone.[9] Estimates of the number of establishments indicate an increase of 9,000 restaurants of all kinds from 1960 to 1971 and a provisional estimate of the number of fast food establishments, at 46,200, indicates an increase of 30,000 operations, nearly a 300-percent growth in the eleven-year period. The indicated decline in non-fast food restaurants of 15,000 establishments is a reduction of six and one-half percent of the 1960 total.

In looking earlier, at productivity rates, it was clear that, in a time of rising wage cost, in an industry with static productivity, the luxury restaurant confronts a difficult situation. Figure 5 presents an interesting case study. Figure 5a represents an operation which features a distinctive counter style fast service restaurant with the bare minimum of personal service available. Figure 5b presents a restaurant with moderate amounts of service but still not in the luxury class while Figure 5c presents the results of a luxury restaurant. (The three operations are located in the same city and owned by the same company). The information presented is shown in the form of an index with 1967 representing a base year. In the low service, counter style restaurant, the average cover remained relatively constant while the average wages per cover fell. Beginning in 1970, wage costs began to skyrocket, and in 1971 it became necessary to begin to raise prices. With this price rise the average number of covers began to fall.

There was no "easy time" in the medium service configuration operation. Wages per cover increased in every year since the base year and the cost of an average cover also rose, and there was a modest reduction in the number of covers served over the time period.

In the luxury restaurant, wages per cover rose more steeply but prices rose slightly less quickly, perhaps because, here, the prices began at a higher absolute level than in the other two cases. In any case, the number of customers fell off substantially.

These three examples can not offer "proof" of anything. They serve to flesh out a line of reasoning, however, regarding the effect of the pressure of wages on prices. The pressure of wages on profits results in necessary price increases and when prices are increased, customers may choose, in a highly competitive market, to seek other alternatives. The question which arises is basically one of price elasticity of demand, and there is simply not enough data to tell us authoritatively the point at which rising prices will drive off more revenue than is earned by the price increase. In the case of the third (luxury) restaurant mentioned above, it can be reported that satisfactory profits are not being generated, and a review of the trade press or, for that matter, of the general business press indicates that the results being achieved in luxury operations across the country more and more approximate those of the third case: falling guest volume and a break-even or losing operation.

Productivity in luxury establishments is relatively low in terms of number of guests served; thus, the amount of labor added is clearly what the customer is paying for. In a zero productivity change setting with rapidly rising wages, the result can only be rapidly increasing prices to the customer. It is an axiom of economics that when prices rise, the demand for goods declines. Thus, as prices in luxury restaurants increase relative to the general price level, we can expect these operations to be relying on a smaller and smaller portion of the population for their clientele. More generally, the successful table service restaurants which have been developed in recent years, like Steak and Brew, Emersons, or Steak and Ale, appear to rely on a fast food format for their success. By reducing the number of choices available to the guests they reduce the number of man-hours required in the kitchen drastically and simplify the work of the service personnel in the front of the house as well. Using a relatively low but consistent quality product (tenderized steak), these operations look very much like the table service restaurant of yesterday, but are, in fact, a stripped down version systemically more like McDonalds than a traditional restaurant. While it is useless to speculate on how long this particular format will be favored by the guests, the relative uniformity or lack of differentiation between operations may make it unusually subject to competition from innovative operators who discover a distinctively different format.

An alternative strategy for survival has been suggested for many years in the adoption of frozen prepared foods to reduce kitchen payroll and simplify operations. Four basic advantages of "manufactured" foods have been suggested. First of all, factory preparation eliminates "the built in inefficiency of the restaurant" in which production is contingent on the arrival and ordering behavior of the guest. Factory preparation also offers significant economies of scale over even the largest commercial restaurants. The factory can also make more efficient use of joint products (such as the various cuts of meat on a carcus as well as trim, bones, etc.) Finally, the space costs of a factory are less, particularly those associated with land cost in typical manufacturing locations as contrasted with land and space costs in a good food service location.[10]

The frozen prepared food strategy, however, has presented a number of difficulties. Basically, operators have found that the quality of frozen foods available was often not acceptable to the better class of restaurant and the variety of quality products available has been entirely too limited. In general, the scale of production required for a frozen food plant or similar operation is such that a limited number of relatively standard products developed fo a national market are the best that can be hoped for. This standard, often undistinguished, product combined with high transportation costs arising from shipping a refrigerated product across substantial distances makes for a product whose advantages are limited.

An alternative large scale production possibility is presented by the equipment systems developed in recent years by Europeans.[11] These equipment systems appear to offer the possibility of high quality small batch cookery using the best methods of freezing in a plant whose size, however, is such that it would logically serve a relatively smaller market and be able to offer wider variety. This equipment is presently being adopted in commissary operations for large state and county institutions and school lunch programs. In this country, the possibility that an institutional food wholesaler or restaurant chain commissary would acquire such equipment in order for that firm to establish itself as a small scale, flexible manufacturer of frozen prepared food seems to be an idea whose time is about to come. Provided rigorous quality control measures are followed, experiments at the Cornell Hotel School, undertaken during the late sixties, clearly indicate that recipes for the very finest foods can be adapted for freezing.[12,13] Work undertaken by the Army suggests that where a chilled rather than frozen food system can be used, superior quality in many products will result, providing the food can be served within 72 hours of preparation.[14] Win Schuler Restaurants operate eight restaurants in Michigan and Indiana using a menu featuring a large number of centrally prepared foods, the majority of which are shipped chilled rather than frozen.

The European equipment referred to earlier, offers the potential flexibility to introduce an element of "custom design" in the manufacture of frozen prepared foods because of the feasibility of relatively short product runs (1000-10000 portions). Thus, the next turn of the wheel may see a resurgence of high quality and variety rather than one more step toward the all-purpose energy pill as the model of dining experience.

Notes

1. John F. Freshwater and John C. Bouma, *Labor Utilization and Operating Practices in Commercial Cafeterias*, Marketing Research Report #824, Agricultural Research Service, U.S.D.A. Government Printing Office, 1969.

2. John F. Freshwater, *Labor Utilization and operating Practices in Table Service Restaurants*, Marketing Research Report #931, Agricultural Research Service, U.S.D.A., Government Printing Office, 1971.

3. John F. Freshwater, *Labor Requirements and Operating Costs in Fast Food Restaurants*, Agricultural Research Service, U.S.D.A., Forthcoming.

4. *Survey on the Restaurant Industry in New York City*, National Committee on Productivity, mimeo, 1972.

5. Thomas F. Powers, "Labor Supply, Payroll Costs, and Changes", *Cornell Hotel and Restaurant Administration Quarterly*, May, 1974, pp. 5-13.

6. Eleanor Carruth, "Restaurants Need Some New Recipes For Survival," *Fortune*, March, 1972, p. 151.

7. *Ibid*.

8. Urban B. Ozanne and Shelby D. Hunte, *The Economic Effects of Franchising*, U. S. Senate Select Committee on Small Business, U. S. Government Printing Office, 1971.

9. Richard Reiss, Jr., *The Speciality Restaurant Industry*, Hayden Stone, Inc., 1973.

10. Alfred N. Califano and Allen Weiss, "The Turbulent Food Service Industry," *Management Advisor*, July 8, 1972, p. 38.

11. Werner Sell, "New Equipment and Systems in Mass Feeding," *Journal of the American Dietetic Association*, October, 1973.

12. C. I. Sayles and H. A. MacLennan, "Ready Foods," Research Report No. 10, *The Cornell Hotel and Restaurant Administration Quarterly*, August, 1969.

13. H. Alexander MacLennan, "Ready Foods, The Application of Mass Production to a la Carte Food Service with Prepared-to-Order Foods." *The Cornell Hotel and Restaurant Administration Quarterly*, February, 1968, p. 56.

14. D. B. Rowley, J. M. Tyomy and D. E. Westcott, Fort Lewis *Experiment: Application of Food Technology and Engineering to Control Preparation*, n.d.

Toward a View
# of Industry Dynamics

Introduction

In the course of conducting this project, the author reviewed numerous articles and publications. Many of them are cited and described in this report; others were not judged to be helpful in the task at hand and are not cited at all. Clearly, then, this article does not constitute an effort toward an exhaustive review of the vast number of articles in the world of food service. Rather, it presents a highly selective review with emphasis on publications which are not a part of the restaurant trade press (though some articles from such publications are presented). Reliance on materials from outside the industry's "establishment" offer us a view of ourselves as others see us. Thus, the content of the article has been shaped not only by the author's interpretation of the literature he reviewed but as well as by the totality of that literature.

Gradually, the outlines of a view of the forces shaping the industry became clear. The balance of this essay presents an overview of these forces and relates them to particular articles which the author found helpful as he formed his views.

Supply Factors

The present age is seen as a "golden age of food supply," and should continue for 25 or 30 years. More intensive cultivation, however, will be necessary to maintain these supply conditions. (Vickerey, 1) While new sources of protein are available in abundance from fish, leaves, plankton, bacteria, and petroleum, we face the cultural problem of keeping eating from becoming a neutral, automatic caloric intake. (Rey, 2)

Labor supply, on the other hand, presents immediate problems to the food service industry because of high turnover and low productivity. While the average annual productivity change in the United States is four percent, there is practically no change in productivity in the food service industry. (Kotschevar, 3)

A significant source of income to restaurant workers come from tips. For waiters and waitresses, however, the hourly income figures available suggest that a high average income for servers employed full time ranges between $6,000 and $7,000. (These estimates are based on a percent of employer food volume rather than employee income reporting, which may be subject to downward bias motivated by tax avoidance.) (O'Connor, 4) Resistance to tipping may be increasing with the growth in packaged vacations and the increasing entry into the market of the cost-conscious traveler. (Anonymous, 5) One answer to the problem of tipping--and to the problem of the minimum wage--is the addition of a service charge. In some instances, the service charge has met with guest acceptance (Musser, 6), but there is also some evidence of guest resistance to service charges. (Anonymous, 5)

Fashion, Style and the Matter of Quality

Not surprisingly, traditional restaurants receive increasingly critical "reviews" as prices rise. Quality of service is seen as extending beyond the server to practices related to tipping, "pushing" drinks, overbooking, credit card acceptance and the like. (Perham,7) Lunch business is booming, but downtown dining spots face serious difficulties with the high tab dinner meal which is forcing many into relocation--or out of business. Some point to the possibility of an industry made up exclusively of fast food establishments and very expensive luxury restaurants. (Anonymous, 8) Others see a decrease in demand for formal dining as a result not only of rising prices but of shifting social customs as well. (Anonymous, 9) A significant number of well known fine dining establishments have closed their doors with factors cited including not only rising labor and product costs but also rapidly rising metropolitan rents and resultantly very rapidly rising restaurant prices. (Carruth, 10)

Fast food offers foods traditionally eaten by Americans (Anonymous, 11), with a shift beginning recently from hamburgers toward such newer entries as pizza (Anonymous, 12) and the very recent emergence of steak as a fast food! (Anonymous, 11) While the somewhat different "all you can eat" format presents an operator with problems, enticement to gorging is becoming an acceptable and successful marketing technique. (Anonymous, 13 and 14) The informal style of the merging popular restaurant often goes to extremes. (Anonymous, 15)

A definable American cuisine exists in an embryonic stage (Anonymous, 16), but the difficulties of delivering high quality food may require the combination of a high volume, popular priced operation with a more service intensive restaurant under the same roof, with two or three operations sharing a common production staff and facilities. (Anonymous, 17)

Ready Foods. One possible approach to making high quality cuisine an economically feasible product is found in frozen prepared foods. A great deal has been written in the trade press about the uses of frozen prepared foods but a series of experiments leading to the perfection of very high quality frozen prepared foods have been conducted at the Cornell Hotel School and may not have received the attention they deserve. The term "Ready Foods" was used as early as 1962 to denote foods which are partially or totally prepared. (Christian, 18) The concept advanced, however, to refer to foods prepared on premise by an operation thus maintaining their own quality standards and, ideally, achieving economies by concentrating expensive, skilled preparation labor in a narrow period while permitting expanded menu variety. (Sayles and MacLennan, 19) Considerable flexibility is offered by fairly lengthy storage times for high quality sauces, and specialized procedures have been developed for handling wine cookery, difficult products, and other special applications. Of particular importance is MacLennan's suggestion of replacing the volatiles by adding a small amount of the original volatile ingredient (for instance, wine) at the time of reconstitution. (MacLennan, 20 and 21) The development of Escoffier's recipes for the "Ready Foods" method suggests that unusually high quality foods can be prepared using these methods. While reports of commercial restaurants converting successfully to the "Ready Food" system were not noted, it is clear that this technique is coming into use in hospitals and institutions. (Sherck, 22)

Marketing

The food service industry has clearly entered the arena of national marketing with the application of such sophisticated marketing techniques as test marketing in selected markets to determine the feasibility of a new menu item for a whole chain (Anonymous, 23); or testing an entire restaurant concept (Anonymous, 24); as well as to making increasing use of the experience gained in marketing by other non-food service retailers. (Anonymous, 25)

The cost of even a relatively uncomplicated television campaign at the national level is impressive. (Anonymous, 26) As smaller chains reach a certain size, they are able to enter the national advertising tourney and begin competing with national chains as well as the independent local operations. (Anonymous, 27 and 28) Smaller chains, however, are able to identify regional markets within which they can "take on" national competition with substantial use of the electronic media. (Anonymous, 29 and 30) Franchise groups are able to mount not only parent company campaigns but also to attract substantial matching expenditures in local markets supporting a national theme through expenditures of local affiliates. (Anonymous, 31)

The development of what is essentially a fast food format with the appearance of a full service restaurant--the format put forward by such growth chains as Steak and Ale, Steak and Brew, and Emersons--is really a marketing innovation rather than a technological innovation. (Anonymous, 32) The difficulties of competition in the media faced by the independent are not only related to a high dollar "entry level" but also to the conceptual and technical difficulties of media campaigns on the part of the independent operator. (Anonymous, 33 and 34) As one reviews articles on food service chains which use extensive advertising, particularly in the electronic media, he is struck by the degree to which the 30 second or 60 second "commercial" format reinforces a simplified menu strategy.

In at least one case, operations research techniques have been found to be helpful in analyzing potential restaurant locations, existing restaurant locations, and existing restaurant performance with respect to location. (Sella, 35)

Fast Food and the Specialty Restaurant

With the development of large national chains, a new and valuable source of information is opened to the student of the Food Service Industry: security analyses prepared by major brokerage houses. Several large firms have developed analysts with expertise in the food service industry. (Anonymous, 36) Perhaps the best known and most successful fast food firm studied by security analysts is McDonalds, who have been successful in every market they have entered, with growth accounted for by both increasing number of units and increasing the average sales per unit. Food and payroll combined typically run just under 60 percent with the firm's expansion being virtually self-funding. (Brody, 37) The "specialty restaurant industry" follows a fast food format systemically but also includes coffee shops, dinner steak houses, and such miscellaneous specialty foods as pizza. (Reiss, 38) The typical fast food customer for fried chicken tends to be a working wife with children, an above average family income but only average social status, a yen for excitment and sociability rather than homemaking and is described as "a stereotype of our modern suburban housewife." (Tigert, Lathrop, and Bley, 39) Changing food consumption patterns are supported by rising education and income levels, greater mobility and leisure, the growing number of working wives, and the development of technology and mass media. (Ulensvang, 40)

Some franchisees have become, themselves, large chains, as is the case with Gino's (Anonymous, 41) Applications of the fast food system are particularly appropriate to such entertainment complexes as Disney World. (Anonymous, 42) The food business continues to be an unique industry in spite of the simpler operating format of the fast food company. This is indicated by the failure of some conglomerates who have entered the hospitality business unsuccessfully. A good example is the unsuccessful attempt of General Foods to absorb Burger Chef. (Anonymous, 43 and 44) As food companies become large, national corporations, problems related to accounting policy, SEC regulations, and similar considerations become a part of the food service manager's set of problems. Accounting problems have been particularly troublesome to fast food franchising companies. (Anonymous, 45) The large companies have developed significant commitments to the international market and are well on their way to becoming multi-national firms. (Anonymous, 46, 47, and 48)

Some Views of the Future

Sales are increasing for the industry as a whole but the luxury restaurant is troubled by fear of violence at night, high prices, and a shift of population to the suburbs. The fast food franchise sector has had its troubles as well, including the substitution of a franchise concept for managerial talent, poor site choices, squabbles between franchisors and franchisees, and accounting irregularities. While the majority of fast food establishments are chain affiliated, 91 percent of the luxury food establishments are independents. (Doty, 49) A quiet revolution is taking place in the restaurant industry basically similar in nature to the evolution of the grocery store from an independent neighborhood store to a chain operation marked by expanding sales volume, reduced customer services, and collective purchasing. (Smith, 50)

Changes anticipated include the increased use of computers and other non-human control systems and devices as well as preparation of foods on a large scale in local operations. (Willett, 51) The possibility exists of a completely automated, computerized restaurant in which the olfactory and visual environment is manipulated. Conveyors could move food to and dishes from the table quickly and automatically. (Avery, 52) A principal means of fighting changing cost patterns in the near and intermediate future is frozen prepared foods. (Califano and Weiss, 53) New kinds of food products may come to substitute for better known ones with increasing frequency as there is evidence that consumers are not only willing to accept artificial flavoring but have even come to prefer it! (Bralove, 54)

The food service industry is now and will continue to be experiencing a belated industrial revolution as it substitutes production line labor and capital for craft labor. Structural change is facilitated by a systems approach with possible emphasis on convenience foods. Some 50 percent of the units are currently reported to be using some convenience foods. (Perkins and Penn, 55) New delivery systems such as monorails are already having an impact on hospital food service (Walek, 56), but perhaps the most fundamental equipment change in view is found in the European food production system referred to as the "cooking street," featuring large quantity, automated food production equipment in a commissary or quasi-factory setting. (Ronan, 57)

Toward a View of Industry Dynamics:

An Annotated Bibliography

Supply Factors

1. James R. Vickery. "Possible Developments in the Supply and Utilization of Food in the Next 50 years." Food Technology, (June, 1971), p. 55.

Changes in the utilization of food for the next 50 years should be able to be predicted fairly reliable since the nutritional, food, and agricultural sciences have been sufficiently developed to provide a firm basis for forecast. The present "golden age of food supplies" should continue for 25 to 30 years, until the pressure of population and economics begin to restrict dietary choice. There is a reasonable chance that food supplies will keep pace with demand, provided we greatly intensify agricultural production by using all available arable land; developing tropical and arid land; using selected animal breeds; utilizing protein source in the sea; and using single-cell protein for animal feed. These innovations will require the work of a wide range of skilled people. The protein-calorie malnutrition problem is most serious in children and is directly proportional to socio-economic conditions and disease patterns. Development of indigenous capacity to pay is of primary importance, for as family income rises, so does its protein intake per day.

2. Louis R. Rey. "The Role of Industry in Meeting the Challenge of Future Food Needs." Food Technology, 25, 26 (January 26, 1971), pp. 26-32.

As man's ability to feed himself has advanced, his involvement and satisfaction with the process has decreased. This presents a challenge to keep an agreeable and relaxing part of life from becoming a neutral, automatic caloric intake, of a mere biochemical and physiological nature. The article states the larger problem is to provide enough food for the peoples of the world. New sources of protein are seen as coming from Fish Protein Concentrate, extraction of protein from green leaves, exploitation of plankton, mass production of protein from monocellular organisms by fermentation, and controlled fermentation of pure petroleum derivatives.

As people become more concerned about health, they face the problem of knowing how food intake and nutritional habits affect physical and mental processes, central nervous system performance and social behavior.

Along with accepting the challenge to feed the world, the food industry is taking over a whole new field: a more biological approach to the welfare and harmonious development of the human being.

3. Lendal H. Kotschevar. "Labor Shortage Intensified by High Turnover and Low Productivity." Hospitals, J.A.H.A., (May, 1972) p. 76

Dietary management is faced with the problems of finding adequate labor and controlling labor costs. Health care facilities, according to the author are understaffed by 4 percent in the food service worker category and by 7 percent in the professional dietitian category. In the decade previous to 1968, wages for food service workers had doubled to $1.68 an hour. By 1980, the average wage for food service workers is projected to be $3.50 per hour. High turnover among food service supervisors and workers is seen as another significant problem. Productivity in the food service industry is half that of other industries. While the annual productivity change in the United States is 4 percent, increases in productivity in food service are so miniscule as to be nonexistent.

Kotschevar suggests that productivity may be increased through the use of prepared foods which reduce the amount of time necessary for preparation. These convenience foods, Kotschevar says, raise food costs by 5 percent while lowering labor costs by 10 percent. Productivity can further be increased by waste of labor. More training of food service workers can help increase productivity.

4. Charles M. O'Connor. "Wages and Tips in Restaurants and Hotels." Monthly Labor Review, (July, 1971), pp. 47-51

A survey of employees in restaurants and hotels covered by the Fair Labor Standards Act indicated that table waiters and waitresses were nearly all classified as tipped employees. In restaurants they averaged $1.14 an hour in wages and $1.80 in tips. Tips averaged substantially more in full course restaurants ($1.93 an hour) compared to other types of restaurants ($1.36 an hour), although wages were nearly the same ($1.14 v. $1.16, respectively). Waitresses, who outnumbered the waiters 4 1/2 to 1 on the survey, generally made less in tips in both the full course ($1.78) and other ($1.33) restaurants than the men ($2.62 and $1.65, respectively). Other tipped restaurant employees received substantially less. Bartenders averaged one dollar an hour in public bars in addition to hourly wages that ranged from $2.21 in the South to $3.06 in the East. Bus help earned $1.43 an hour in wages and 42 cents an hour in tips (generally through a sharing arrangement with the waiters and waitresses) in full course restaurants and $1.54 an hour plus 12 cents in tips in other restaurants. Bellmen earned $1.23 and hour in wages and $1.18 in tips.

5. Anon. "Tipping: Travel's Tedious Tax." Cornell Hotel and Restaurant Quarterly, Vol. 8 (February, 1968), pp. 43-50.

The cost of packaged trips often does not include gratuities. Tips are resented when they come as a surprise after the guest thinks he has determined his vacation cost in advance. This problem is increasingly acute among the growing number of budget-conscious purchasers of packaged vacations from the lower middle income and young age groups recently entering the travel market. Tipping is of greater significance to waiters, waitresses, and bellmen than to other hotel and restaurant employees. For those who receive them, tips are often largely tax free because of under-reporting. The tip began as a means of offsetting a low wage, and the tip credit provisions of the minimum wage law perpetuates that discrepancy. One way to eliminate tipping is the institution of a service charge. There is some evidence, however, of guest preference for voluntary tipping and resistance to a service charge.

6. R. D. Musser. "Answer to the Tipping Problem." Cornell Hotel and Restaurant Quarterly, Vol. 8 (February, 1968), pp. 99-101.

The author discusses the no-tipping system instituted at the Grand Hotel, a resort hotel that caters to conventions, on MacKinac Island between Lake Michigan and Lake Huron. The no-tipping system was introduced in an effort to deal with a stringent minimum wage passed by the Michigan Legislature in 1964. The system was designed to provide salary credits for room and board provided by the resort to its employees.

The system involves an automatic 15 percent service surcharge on all guest bills. Employees are paid a small salary and are given an incentive pay to maintain quality service. Reaction by patrons to the no-tipping system has been highly favorable and employees make the same money as they did before the no-tipping policy. While payroll has increased from $350,000 in 1964 to $850,000 in 1968, the increase has been offset by employee payments for room and board and collections from the 15% service charge.

Fashion, Style and the Matter of Quality

7. John C. Perham. "The Restaurants That Executives Hate." Duns Review, (December, 1972), pp. 57-59.

Top business executives are giving vent to their feelings about the current state of fine dining. Despite company expense accounts, executives are appalled at the dramatic price increases at top restaurants. Exacerbating the situation is the selectivity of luxury restaurants about credit cards they will accept, with many of the most expensive refusing to accept any. Businessmen find many of the same restaurants "complacent and sloppy" with neither food nor service comparable to their prices. Further, the short shrift given the non-drinking customer and the intense pressure applied by restaurant staff to tip heavily is especially rankling to the businessmen interviewed. Finally, some luxury restaurants tend to overbook reservations--sometimes meaning waits of over two hours. The feeling among top executives is that fine dining is becoming an increasingly rare pleasure.

8. Anon. "Dining Out in America - How Old Ways are Changing." U. S. News and World Report, (April 20, 1970), pp. 92-94.

Dining out is undergoing change that has a profound impact on the restaurant business. Lunch-time business is booming, but at night, downtown restaurants are empty, forcing many to close or relocate. With money so tight these days, most families can no longer afford the luxury of eating out. Those who can, patronize either suburban restaurants or less expensive, fast food services. Rising cost prices and the difficulty of finding and keeping reliable help also hurt the restaurant business. In the future, we may see only the elegant restaurant and the franchise, fast-service type, with nothing in between.

9. Anon. "Toast Farewell to the Two Hour, Seven Course Dinner." Advertising Age, (October, 1971), p. 45.

The retreat and eventual abandonment of the full course dinner is seen by the author as a result of shifting social customs and habits and severe economic pressures on the restaurant industry. The declining tendency of the family to eat as a unit, the trend toward consumption of less food on an increasing number of occasions during the day--all suggests the demise of the full course dinner menu. A generation weaned on fast foods is liable to view the formal dinner with positive aversion. Increasing labor and food costs have almost completely undermined the economic viability of the full course dinner menu.

The article foresees the replacement of the full course dinner menu with a limited selection of entrees of high quality much in the same manner of the abbreviated menus of France's four-and three-star restaurants.

10. Eleanore Carruth. "Restauranteers Need Some Recipes for Survival." Fortune, (March, 1972), p. 91.

A large number of fine restaurants have closed their doors and some are speaking of the end of an era. This development is noticeable not only in New York but in 15 major cities studied across the United States. The difficulties of the fine dining establishment are attributed to exploding labor costs, union pressures, limited or zero growth in productivity, rising raw product costs with meat and fish showing the greatest rise. For downtown restaurants a significant pressure is that of ballooning real estate values with the square foot rental charge of $6.50 in one area going to $40 when the old buildings were replaced with new ones. In six years, there has been a 70% increase in prix fixe menus at New York's very top restaurants while a 50% increase was noted in a broader sampling of 70 "good to finest" New York restaurants. Changing styles make the formal restaurant seem "passe" to many operators and customers.

11. Anon. "The Roadside Gourmet: Pop Goes the Food." Newsweek, (September 25, 1972), pp. 76-78.

In 1971 there were 35,547 franchised fast food outlets throughout the United States with a gross of $5.3 billion. Projections for 1972 indicate a 22 percent increase to $6.5 billion. The franchise fast food outlet or "pop" restaurant is characterized by inexpensive prices and produce uniformity. According to this article, items of pop restaurants are nothing new. "Pop" restaurants cater to the traditional American taste for hamburgers, hot dogs, fried chicken, and ice cream. Exceptions are relatively new items such as tacos, pizza, and steak. Pop food's emphasis is on the slick packaging of old staples and the employment of the most modern marketing and merchandising techniques.

The newest twist in the fast foods industry is the steak house. Characterized by the same standardized, strictly limited menu, the steak house offers up a more luxurious decor and higher prices. The history of the fast foods industry has been one of heady growth. Yet with many areas now saturated with franchises, rapid expansion seems less likely. Furthermore, there appears to be an incipient revolt of franchise owners who are claiming that the parent corporations elevate prices and restrain trade by requiring them to buy standardized products. Yet with a one-fifth share of the $30 billion that Americans spend for food in all hotels and restaurants, the "pop" restaurant industry's future seems bright.

12. Anon. "A Palate Revolution." Forbes, (February 15, 1971), pp. 35,37.

This article deals with the growing popularity of pizza with the American palate and its importance in the fast foods industry. According to a recent Gallup Poll commissioned by Food Service Magazine, the 21 to 34 age group has switched allegience from hamburgers to pizza. Demonstrating the growing popularity of pizza is the growth of Pizza Hut, Inc. of Wichita, Kansas, with 700 stores and sales of $22 million and the largest of the chains, Shakey's owned by Great Western Stores, with 350 stores and sales of $68 million a year.

While pizza is not a true fast food item--it takes 12 to 15 minutes to prepare--technological innovations such as frozen pizza buns (Losurdo Bros. of Moonachie, New Jersey) which when thawed become dough for an oven fresh pizza are speeding up preparation. Frozen pizza sales are also expanding with Grand Union supermarkets reporting an annual doubling of sales and Kraftco, Inc. ready to make a major entry into the frozen pizza market.

13. Anon. "The Importance of Being Greedy." Time, (October 23, 1972), p. 72.

The article describes the trials and tribulations of the "all you can eat" restaurant, like the Howard Johnsons's Restaurant in Spring Valley, New York, where high school students arrived on one chicken night (all the chicken you can eat for $1.69) and consumed 360 pieces of chicken (90 pounds). Some establishments see the person who eats too much as excellent advertising.

In addition to catering to galloping gourmands, restaurants that offer unlimited seconds have to deal with individuals who smuggle out food. A manager of a Shakey's Pizza Parlour in California discovered a patron walking out with 200 pieces of chicken stashed in a guitar case. Despite these difficulties, the "all you can eat" theme seems to be gaining in popularity throughout the restaurant industry.

14. Anon. "All You Can't Eat." Newsweek, (October 8, 1973), pp. 89-90.

The popularity of buffets and smorgasbords with the eating public has increased dramatically over the past few years. Restaurants specializing in "all you can eat specials," threatened by sky-rocketing food costs have had to tighten their belts. Howard Johnson's new approach advertises "seconds on the house" rather than "all you can eat." Some restaurants have been forced out of business while others have had to raise prices as much as 15 percent since the first of the year.

15. Anon. "Waiters on Wheel." Newsweek. (December 11, 1972), p. 116.

Putting waiters on roller skates may be the answer to increasing waiter productivity with two Eastern restaurants pointing the way. The owners of La Nicoise, a French bistro in Washington, D.C., hoping to dispel the traditional stuffiness of French restaurants, placed their serving staff on skates for the dinner shift. Accidents are few, but on one occasion a chocolate mousse was dropped on a senator. An added attraction is an hour of cabaret held nightly performed by waiters and maitre d'--all on roller skates.

The latest entry into the restaurant roller derby is the Eighth Street Gallery, a pub-like restaurant owned by the Horn and Hardart chain. Roller skating waiters were introduced as a zany come-on, but the gimmick has proved to be a practical innovation.

16. Anon. "Is There Really an American Cuisine?" Saturday Review/World, (November 20, 1973), pp. 28-35.

This article is a collection of writings describing the contribution made by various regional kitchens to the emerging American cuisine. American cooks have adapted cooking skills brought from the Old World and those learned from the Indians to utilize the new and strange native foods; they have also created new cooking, baking, and preserving methods. From a blending of the food habits of many peoples, there is emerging a true and recognizable American cuisine.

17. Anon. "Kennedy Center: 3 in 1 Combo." Institutions/Volume Feeding," 70 (May 1, 1972), pp. 68-69.

Coordination is the key to the Canteen Corporation's operation of the Kennedy Center's three restaurants--Promenade Buffeteria (a cafeteria), The Gallery (an intimate cafe), and LaGrande Scene (haute cuisine). All meals (over 10,000 a week) are prepared in one ultra modern kitchen equipped with two especially designed tilting braising pans with cooking areas up to 12 square feet and self generating heating units. Quality standards for food are identical in all three restaurants.

An example of the meticulous coordination involved in Canteen's operation is seen in the red snapper with lobster served at La Grande Scene that, with the addition of shrimp and scallops, becomes the Seafood Newburg for the Gallery. The ends of the snapper are utilized in the creole sauce for the cafeteria. To insure top quality in the cafeteria operation, policy requires that at least one of the chefs eats a meal in the cafeteria each day. Executive chef Claude Bouchet inspects the cafeteria line each morning. Staffing requirements for the three restaurant operations include a cooking and preparation staff of 25 under the Executive Chef, 30 in cleaning a maintenance, 35 waiters and cocktail waitresses.

18. Vance A. Christian. "Ready Food Research at Cornell." The Cornell Hotel and Restaurant Administration Quarterly, 3:1 (May, 1962), pp. 14-15.

Christian reports on a survey conducted by the School of Hotel Administration at Cornell University on the production of "Ready Foods" by food manufacturers for the hotel, restaurant, and institutional market. "Ready Foods" are menu items that are either partially or totally prepared and require only one production operation for serving.

A research program was established to examine the factors of cost, preparation methods, and customer acceptance of "Ready Foods". The goal of the study is seen as determining the utility of "Ready Foods" in helping the hotel and restaurant industry deal with the problems of increasing labor, food and equipment costs, and the lack of skilled cooking personnel.

19. C. I. Sayles and H.A. MacLennan. "Ready Foods: The Application of Mass Production to a La Carte Food Service Using Prepared-To-Order Food." The Cornell Hotel and Restaurant Administration Quarterly, 6:12, (August, 1965), p. 21

A rising wage scale, increased food costs, low labor productivity, and lack of skilled help are the difficulties with which the food service industry as a whole must deal. They are especially critical to food service operations in hotels and in high quality restaurants. This article is a preliminary report on a research project undertaken by the Cornell School of Hotel Administration called "Ready Foods--The Application of Mass Production to a la Carte Food Service Using Prepared to Order Food." "Ready Foods," according to the article, is a term applied to food that has been processed to the point where it can be kept for a convenient period of storage. Such processing includes packaging the food in individual portions.

Advantages of "Ready Foods" are numerous and center on the economies of mass production. One highly skilled chef can supervise mass production of "Ready Foods" with less highly trained cooks doing the actual work. "Ready Foods" allow menu expansion at a minimum additional cost and allow resort hotels and other hotels with seasonal peaks and valleys in occupancy to utilize their facilities more efficiently. "Ready Foods" offer hotel restaurant operations the opportunity to increase sales volume and profits as well as to institute more effective inventory and cost controls. Included in the article are a list of 33 "Ready Food" items with portion cost information for various appetizers, entrees, and desserts.

20. H. Alexander MacLennan. "Ready Foods Research Advances at Cornell." Cornell Hotel and Restaurant Administration Quarterly, 8:1 (May, 1967), pp. 114-116.

The article states that a combination of increased labor costs and scarcity of skilled culinary personnel has resulted in the limited menu consisting of easily prepared roasts and grilled items--augmented by a few pre-cooked frozen foods--purchased from food processors. The Ready Foods concept of on-premises mass production of menu items which are then individually portioned and frozen for future use is suggested as an alternative to the receeding menu--a menu of even fewer choices.

Research done by the Cornell School of Hotel Administration on the adaptability of various food items to the Ready Foods Process indicates that bases may be stored for up to three months with no loss of quality. Basic sauces may be kept for up to five weeks. The best procedure for recipes requiring wine is to add half the allotted amount of wine before packaging and freezing and the remainder during reconstitution. Such foods as french fried potatoes or eggplants should be partially deep fat fried before packaging and freezing. During reconstitution, the items should be immersed in deep fat, allowing the thawing, heating, and cooking processes to continue simultaneously. The use of Ready Foods in a demonstration by the Cornell School of Hotel Administration suggests that a 27.2 percent departmental profit on hotel restaurant operations (without the aid of the banquet trade) is possible as a result of the utilization of Ready Foods.

21. H. Alexander MacLennan. "Ready Foods." The Cornell Hotel and Restaurant Quarterly, 8:14 (February, 1968), pp. 56-68.

MacLennan foresees the introduction of the Ready Foods concept as a remedy for the mounting red ink, the decline in food quality, and the radical reduction in menu selections in hotel food service operations, Ready Foods are distinguished from convenience and other prepared foods by several factors. Preparation is in large quantities and performed on the premises. As no more than three or four foods are prepared in any one day, there can be complete supervision by the master chef, a return to classical cooking methods, and no need for synthetics or food additives. Freezing is employed as the method of preservation and storage, so serving requires a simplified reheating process. Single portion packaging prevents the quality deterioration that normally accompanies long periods on a steam table. Ready Foods prepared and packaged on premises can also accommodate local tastes and different portion sizes.

The adaptability of Ready Foods to the demands of haute cuisine is supported by the use of recipes by Escoffier in testing the viability of the Ready Foods concept. Start up costs for the implementation of the Ready Foods concept involves purchase of a blast freezer, increased zero degree refrigeration storage areas, some reheating equipment, and larger food inventories. Ready Foods, through mass production, reduces both food costs and labor costs per portion and helps avoid food wastage. Menus can be expanded at minimal costs, and such high profit items as appetizers, soups, and desserts can receive greater promotion. One master chef can oversee the entire program of food production and exercise close supervision of the few items prepared each day. Classical recipes or the chef's own recipes can be incorporated, and all recipes can start with fresh foods. Local tastes can be catered to more readily. Finally, greater accuracy can be attained in cost figures for food production and inventory control.

22. Charles K. Sherck, "Changes in Food Consumption Patterns." Food Technology, 25 (September, 1971), pp. 50-52.

The author examines changes in food consumption patterns. Currently the food service segment of the food industry (both institutional and restaurant) accounts for 30 percent of the American consumer's food dollar, and this figure is expected to increase to 50 percent. Within the institutional market, rising labor costs and lack of trained food service personnel have caused a marked increase in the use of convenience foods, frozen entrees, premade individually wrapped sandwiches, and other pre-prepared items. A growing trend in hospital feeding is the elimination of food preparation as a part of the hospital function. Food is prepared in individual servings off site, then shipped to the hospital where it is reheated in microwave ovens. School lunches are expected to increase from 4 billion to 8 billion by 1976. Within the restaurant sector of the food service industry, fast food outlets show the fastest rate of growth.

Socio-economic trends that will affect the food service industry include educational level, income, travel, urbanization, leisure activities, number of housewives working, disappearance of the family meal, and disappearance of the three-meal-per-day regimen. Emphasis on the slim trim look by the young and educated, concern for health, and increasing emphasis on nutrition and nutrition education will also have major impacts on the food service industry.

Marketing

23. Anon. "McDonald's for Breakfast? We're Working On It." Advertising Age, 43 (September 11, 1972), p. 52.

McDonald's, the hamburger fast food franchiser, has begun test marketing breakfast at some of its outlets located in Chicago, Pittsburgh, and Washington. The new menu item is a fried egg served on a muffin. The article suggests that it is doubtful that it will be seen nationally at every McDonald's outlet as there are over 2,000 outlets and some franchisees may reject menu additions. Another addition to the McDonald's menu is the Tripple Ripple, a three flavored cone, frozen hard enough so that it can be purchased with the rest of the meal and be soft enough to eat when it is time for dessert.

24. Anon. "General Mills Open First Betty Crocker Restaurant in Dallas." Advertising Age, 40 (July 28, 1969), p. 74.

General Mills is opening the first of its Betty Crocker Tree House Restaurant and Bake Shops in Dallas in Novemeber, 1969. Four additional test restaurants are planned for openings by June, 1970, in various parts of the country. The Dallas operation will sell various baked goods and 20 different kinds of cookies and will include a cater-counter to sell takeout foods for lunches.

25. Anon. "Pre-printed Coupon Insert Results Told." Editorial Publisher, 104 (July 24, 1971), pp. 31-32.

The article outlines in detail the use of the pre-printed coupon insert advertising campaign conducted for Arby's Roast Beef Restaurants. The campaign centered on getting the customer to try an Arby's roast beef sandwich. To this end, he was induced by the offer of a free milk shake with each sandwich purchase and a coupon. The campaign had a 20 percent response.

26. Anon. "Burger King Drive Has $1,000,000 Promotion Tag." Advertising Age, 42 (September 13, 1971), p. 2.

Burger King Corporation has budgeted $1,000,000 for a Saturday morning and prime time series advertising campaign. The network drive will be primarily directed toward a Saturday children's series and will introduce a new animated consumer spokesman dubbed "The Burger King" and a new theme "where kids are king." In addition, six million theme book covers will be distributed. This new campaign indicates a shift in emphasis from the adult market to the children's market. Burger King entered network TV in the spring of 1971.

27. Anon. "Pizza Hut Has Basketball in '72 Ad Plans." Advertising Age, 43 (April 17, 1972), p. 85.

Pizza Hut, Inc. moves into national advertising with plans for 1972 centered on sports and especially on its sponsorship of a college all-star basketball classic carried by 120 TV stations across the country. Computerized ballots are available in local Pizza Huts. The special will include 18 minutes of commercials. Pizza Hut, Inc. is relatively new to national advertising; its first campaign began in 1970.

28. Anon. "Shakey's Opens Its Big Ad Guns on Hamburgers, Chicken." Advertising Age, 42 (December 27, 1971), p. 3

Shakey's Pizza Parlors mounts a new advertising campaign designed as a frontal attack on the two leaders in the fast food business, McDonald's and Kentucky Fried Chicken. The strategy is to allow these two giants, with advertising budgets of $25 million and $10 million respectively, to convince the American family to go out and eat, at which point Shakey's hopes to persuade the family that there are better alternatives to hamburgers and chicken. The 1972 budget is set at $3 million.

The theme of the ad campaign, "Shakey's Feeds You Fun," projects Shakey's as a cross between a family eating place and a beer hall with heavy Gay 90's motif.

29. Anon. "Church's Initial Campaign Tests in Dallas--Fort Worth." Advertising Age, 44 (June 25, 1972), p. 31.

Church's Fried Chicken, Inc., with 500 outlets in 23 states will launch its first advertising campaign in June of 1973. Church's distribution strength is mainly in the Southeast and Southwest. The initial test will utilize radio and TV in the Dallas-Fort Worth area. The theme of the advertising campaign will be "The golden test of Church's comes ringing through." Text expenditures are expected to exceed $200,000 in a 12-month period.

30. Anon. "Pup 'N' Taco TV Stresses 'Fun' Image." Advertising Age, 42 (September 7, 1971), p. 18.

Pup 'n' Taco Drive Up, operator of 50 fast food outlets in the Los Angeles area, initiated a $100,000, five-week TV spot campaign oriented towards promoting hot dogs and tacos as fun to eat. Hot dogs are seen as associated with such "good times" as ball games, picnics, and circuses. This is the chain's first major advertising campaign.

31. Anon. "International Pancake House TV Spots Use Grid Action." Advertising Age, 42 (September 27, 1971), p. 8.

International House of Pancakes, Inc. initiated an advertising campaign for the 1971 football season, to promote sales of official miniature helmets at participating restaurants in the national chain. Television spots in 90 markets plus full page advertisements in Boys Life and Scholastic will be employed. Seven advertising agencies served cooperative groups of franchise owners in coordinating and supplementing national materials. Budgeted expenditures for the International House of Pankcakes advertising program in 1971 were $1,000,000, and $10,800,000 when local cooperative efforts were added.

32. Anon. "New Concepts Work for Steak and Brew." Advertising Age, 44 (April 9, 1973), p. 46.

The success of Longchamps, Inc.'s Steak and Brew chain, which has expanded to 50 locations within the heavily populated East Coast corridor, can be, according to the article, attributed to its emphasis on the preferences and budgets of the young. Steak and Brew outlets are designed with an English pub motif and with heavy emphasis on informality--"a casual place where you can almost hang out." The menu is limited so that the check won't get out of hand. Furthermore, Steak and Brew employs the concept of unlimited bread and salad, plus all the beer, wine, or sangria a person can drink. As a result, Steak and Brew's clientele is the young, the working class family, and surprisingly, the upper class at leisure time. Average sales for the 29 company-owned units is $950,000--all at locations where restaurants had previously failed.

33. Anon. "Two Admen Customers of Tea Room Create Ads for Owner, Fee is Food." Advertising Age, 40 (November 10, 1969), pp. 78,80.

This article discusses an advertising campaign for a mid-Manhattan restaurant, the Russian Tea Room. The campaign was designed to change the image of the restaurant from that of finger sandwiches and petits fours to that of a sophisticated specialty restaurant. Full page ads in the New York Times emphasized menu entrees, and the reaction has been impressive. The campaign was created by two advertising firm executives as a "due bill" arrangement (that is, in return for food and services from the restaurant).

34. Anon. "Customers Know More About You: Are You Learning About Them?" Institutions, (April 15, 1973), pp. 68-79.

Patron research often deals with demographics rather than patron attitudes. New research services can expand these boundaries with such methods as a patron dairy approach or behavioral research. A customer's reasons for his choice are often multiple and complex. Food services can only benefit from a fuller knowledge of the customers and their preferences.

Burger Biggie, a carry-out franchise chain, found that its position of area dominance was beginning to decline. Using market segmentation to get at the causes of then decaying popularity, they were able to define cleanliness and high prices as the areas needing improvement. They embarked on a program of positive corrective action and subsequently began to regain the market. Market segmentation can be effective not only in such defensive action, but also to probe the market ability of new concepts or new avenues for existing operations.

35. Francis R. Salla. "Computer Evaluation of the Restaurant Site." Cornell Hotel and Restaurant Quarterly, (November, 1968), pp. 25-31.

This article reports the use of a computerized mathematical model to aid in site selection. Quantitatively, factors incorporated in this model include population, income, advertising budget, number of competitors, and traffic volume. Qualitative factors such as neighborhood characteristics, ability of the manager, and site visibility are quantified with a 1 - to - 10 scale. Five models were originally constructed for (1) general restaurants, (2) drive-ins, (3) hamburger places, (4) cafeterias, and (5) specialty restaurants. Subsequently a sixth model for highway restaurants was developed, and specialized models were constructed for a number of franchised restaurants. Actual empirical values (such as traffic count: 12,000; the number of parking places; or distances to motels) are substituted in a complex set of equations. Computer solution of these equations results in a dollar volume prediction that has so far been highly accurate. The model is useful not only in selecting new sites, but also in evaluating current operations and analyzing potential for new volume. The accuracy of the input data is of critical importance.

D. Fast Food and The Specialty Restaurant

36. Anon. "Restaurant Industry." The Wall Street Transcript, XLII: 7 (November 12, 1973), pp. 34929-25008.

A round table discussion presents the views of five security analysts who have specialized in the restaurant industry. The participants are Alice J. Bradie (Paine, Webber, Jackson and Curtis, Inc.), Carl F. DeBiase (Moore and Sehley, Cameron and Co.), Richard Reiss, Jr., (Hayden Stone, Inc.), Alfred L. Simon (Sanford C. Bernstein and Co.), and Janet W. Tanner, (Aetna Life and Casualty Insurance Group).

37. Alice J. Brody. "MacDonald's: A Security Analysis." Research Department, Paine, Webber, Jackson and Curtis (1973)

Virtually every market MacDonald's has entered, from rural to urban, has proved successful and now accounts for an 11 percent growth compounded since 1961. Revenues are derived from licenses, rentals, service fees, and operations. Food sales estimates are accounted for as follows: hamburgers, 49 percent; french fries, 15 percent; fish sandwiches, 7 percent; beverages, 23 percent; and desserts, 6 percent. Food costs typically range from 36.5 percent to 37.5 percent of sales. Daily inventory assists in maintaining minimum waste. Payroll, assuming a $2.00 minimum wage, is $300 per day with payroll cost accounting for approximately 21 percent of sales. Advertising and promotion requires 4.5 percent of sales with 1 percent going for national advertising and .5 percent for in store promotion. Prospects for MacDonald's continued growth in sales and profits appear bright, but the fast food competitive environment is becoming increasingly more difficult with only the best run firms surviving. MacDonald's expansion is seen as virtually self-funding because of high profits and favorable cash flow.

38. Richard Reiss, Jr. The Specialty Restaurant Industry. Research Department, Hayden Stone, Inc., (February, 1973).

Reiss sees the specialty restaurant as having four basic sets of characteristics: (1) common ownership bonds; (2) centralized control with decentralized management; (3) easily recognizable, proven format; and (4) competitive prices, limited menus, and low labor content. Within the overall specialty restaurant format, he sees four categories: (1) fast food, (2) coffee shops, (3) dinner houses, and (4) miscellaneous. Six facts are crucial to the success of a specialty restaurant: (1) real estate and site selection and development expertise; (2) access to permanent capital for new unit expansion; (3) creation of material or regional franchise (brand) through standardization of operating procedures and standards, national, regional, and local advertising and marketing; (4) superior management training and compensation programs; (5) strict operating and financial control procedures; and (6) the discipline to stay with a proven operating format and restrict expansion to manageable proportions. Reiss reviews five firms in depth: MacDonald's, Sambo's, and Pizza Corporation of America, Denny's and Emersons's Ltd.

39. Douglas J. Tigert, Richard Lathrop, and Michael Bley. The Fast Food Franchise." Journal of Retailing, (Spring, 1971), pp. 81-90.

In January, 1969, a 25-page questionnaire was mailed to a panel of 1000 homemakers. The 85 percent returns gave information on fast food chicken purchases, and a well-defined demographic profile of the heavy user emerged: a full-time worker; young; in a family with slightly more children than the sample's average; and in a family with a significantly higher family income than sample average but with average educational and occupational status. Further, data regarding life style indicate a homemaker who seeks excitement, is concerned with how she looks, is less concerned about homemaking and cooking, is not particularly oriented toward her home and children, and is active socially. The authors conclude that "she is the stereotype of our modern, suburban housewife."

40. Leon P. Ullensvang. "Food consumption Patterns in the 70's." Vital Speeches of the Day, 1970, pp. 240-246.

The past decade has been a period of remarkable change, especially evident in our changing food patterns. The consensus prognosis for the 1970's is continued change. Rising education and income levels, greater mobility and leisure, the growing number of working wives and the development of technology and mass media will all have a tremendous impact on our food habits. Family meal patterns are rapidly changing while the quest for convenience and greater diversity continue. The ways in which food is acquired and prepared are also changing, with growth occurring in large chain units, small convenience stores and away from home feeding.

The basic forces which will affect product success in the future are hedonic satisfaction, convenience, changing meal patterns, and eagerness to try new products regardless of their origin. Consumer needs will be more intellectual, reflecting new life styles and the affluent mentality. Marketers must be quick to spot changes, interpret them into meaningful products and services and deliver these products in such a way as to elicit positive responses.

41. Anon. "Record Results on the Menu." Financial World, (May 16, 1973), p. 23.

One firm that has successfully capitalized on the fame of its owner is that of Gino's, Inc. owned in part by Gino Marchetti, a star defensive end with Baltimore Colts. The company which has 342 units, all company owned, is located mainly in Maryland, eastern Pennsylvania, Delaware, New Jersey, and the Washington, D.C. area. Its menu consists of Colonel Sande 's Kentucky fried chicken, hamburgers, and other complementary fast food items. Sales in 1972 were 128 million dollars.

Attempted expansion into Connecticut and the highly competitive Los Angeles market resulted in a 1.8 million dollar loss when the company divested itself of the 21 unprofitable units in these states in 1971. Gino's now concentrates on its mid-Atlantic market. Expansion plans center on Rustler Steak Houses, economy steak houses, and encouraging results with the 22 units presently in operation have led the company to project the opening of 200 additioanl Rustler restaurants in 1974 and 1975. First quarter earnings in 1973 were a 43 percent year-to-year advance on a 25 percent sale gain.

42. Anon. "FF Helps Feed Vacationers at Disney World Complex." Quick Frozen Foods, (February, 1972), p. 35.

Disney World, the $400 million entertainment complex about 20 miles southwest of Orlando. Florida is the fast food company's Nirvana. Designed to be self-contained, Disney World will include five hotels and enough restaurants to feed the thousands of hungry tourists expected to stream through the entertainment complex when Phase I of its building program is completed. Fast food companies already involved are the kitchens of Sara Lee which operates an old fashioned bake shop on Main Street U.S.A. and the Florida citrus industry through its Sunshine Pavilion.

43. Anon. "The Bigger They Are..." Forbes (Gebruary 15, 1972), p. 21.

The article examines the giant $2.4 billion food conglomerate General Foods' retreat from the fast foods industry. The corporation announced the closing of all of its 70 Rix Systems Inc. hot roast beef restaurants and the closing of at least 100 of its 1,200 Burger Chef units.

Reasons given for failure were the inability to attract customers into Rix stores and the loss of key top management personnel in both Rix and Burger Chef divisions. Adding to General Foods' woes was its discovery that long term lease committments are debts, especially if the store fails. Pre-tax losses for General Foods in its fast food ventures totaled $83 million, or nearly one dollar per share after taxes.

44. Anon. "Rix, Burger Chef failures leave GF with a Bad Taste." Advertising Age, 43 (February 21, 1972), p. 130.

Difficulties in General Foods fast food outlets have resulted in the closing of all 70 of the Rix Roast Beef restaurants and over 100 Burger Chef units. GF acquired Burger Chef in 1968 at which time there were 700 units, 20 percent of which were company owned. By 1971 there were 1,200 units and 34 percent were company owned. Despite a "new strong management team" installed by GF, a $47 million net loss write off in the third quarter was found inevitable.

General Foods' difficulties in the fast food industry has been attributed to inexperience in the field, and the loss of key executives in the Rix and Burger Chef systems.

45. Anon. "Well Done!" Forbes (June 1, 1973), pp. 32-34.

The article deals with a recent situation in which Dunkin Donuts, ($]27 million in sales) the franchise food outfit, fired its certified public accountant, Price Waterhouse, a prestigious "Big Eight" CPA firm. Price Waterhouse had insisted that Dunkin Donuts adopt a more conservative accounting procedure for interest on short term notes. Upon opening a new shop, Dunkin Donuts generally borrowed money to cover all construction and equipment expenses usually in the form of a seven-year note. Interest on the note was divided equally over seven years, rather than treated as a traditional mortgage (i.e. initial high interest payments declining over the life of the mortgage). This accounting policy inflated reported earnings 4 percent in 1970, 9 percent in 1971, and 11 percent in 1972. As Dunkn Donuts is in the midst of rapid expansion, the inflation of reported earnings would increase at even a greater rate. Dunkin Donuts made the suggested change in accounting practice and then fired Price Waterhouse.

The Securities and Exchange Commission now requires the filing of Form K-8 when a corporation changes auditors. The corporation must report the change and file a statement listing any material differences over accounting policy that had occurred in the preceding 18 months and whether these disagreements were resolved to the auditor's satisfaction. The ex-auditor then must file its own affidavit stating whether or not it agrees with the company's version of the dispute. Thus disputes between corporations and auditors are now public, offering some modicum of protection to the investor.

46. Anon. "Colonel Sanders Spreads His Wings." Business Week, (January 24, 1970), pp. 47-48.

Kentucky Fried Chicken is attempting to scale the walls of that traditional custom of fish 'n' chips--Great Britain. Colonel Sanders Kentucky Fried Chicken has 14 shops in Great Britain, most of them located in London. The British operation is operated through a franchise agreement with two Britishers, Brian Balachin and Keith Boorman. Plans call for the opening of 100 additional outlets throughout the United Kingdom.

47. Anon. "General Mills Plans Brussels Restaurant." Advertising Age, 40 (September 22, 1969), p. 8

General Foods plans to open a fast food restaurant in Brussels this month in a joint venture with Belhaize, Belgium's largest retail food chain. The restaurant will have a limited menu featuring roast beef sandwiches and will have sit down and carry out service. This unit is the first to be opened under an agreement with Performance Systems, Inc. giving General Mills exclusive franchise rights to develop Minnie Pearl chicken and roast beef concepts in Europe and the British Isles. An additional fast food restaurant concept is being tested by a General Mills English subsidiary which opened Smithy's, a restaurant featuring carry out chicken and chips located in London.

48. Anon. "Will Big Mac Meet Its Match in the Land of the Rising Sun?" Forbes, (May 15, 1973), pp. 118-130.

The reputed fast food invasion of Japan may in fact be a route of the American corporate invaders. The Japanese market would seem ideal for the fast food franchisers--100 million people who spent over $10 billion in 1972 in more than 300,000 restaurants, mostly "mom and pop" operations. Corporations lured by this market include General Foods Burger Chef, McDonald's, Dunkin Donuts, United Brands A & W, International Multifoods' Mister Donut, International Dairy Queen, Pizza Hut, and Britain's Wimpy Ltd. Mister Donut, Dunkin Donuts, A & W, and Wimpy have simply licensed their systems to Japanese companies working on a straight royalty basis. Burger Chef attempted to go it alone with disastrous results. Most other corporations have wisely affiliated themselves with Japanese trading companies.

Problems confronting American fast food corporations in Japan are uniquely different from those encountered in the U.S. McDonald's has had to deal with blatant imitation. One local hamburger chain, Lotteria, builds its outlets to look identical to McDonald's with the exception of name and colors. Shortages of skilled manpower and qualified franchises have forced American companies to delay outlet openings and to place increasing emphasis on company owned outlets. Severe beef shortages due to government import quotas and government protection of domestic beef raisers make providing outlets with the required food in the necessary quantities a significant problem.

Furthermore, finding proper locations for outlets poses a significant problem. Real estate is at a premium in Japan and successful outlet locations must be located in downtown shopping districts. Purchase prices of land is prohibitive and rental rates are being driven up by competition among fast food companies. Expansion plans are seriously behind schedule.

E. Some Views of the Future

49. Jay L. Doty. "Outlook for the Restaurant Industry." Cornell Hotel and Restaurant Association Quarterly, (May, 1971), pp. 21-22.

According to Doty, sales in the restaurant business have risen at an average annual rate of 6.5 percent since 1965 as compared to 6 percent for expenditures at retail food stores. Luxury food service accounts for 20 percent of the food service industry's dollar sales with 91 percent of all establishments in this category independently owned--indicating the viability of this concept. Eighty-two percent of all restaurants are located in downtown areas while the major population shift has been to the suburbs. Difficulty commuting back to the city at night, fear of crime, and high prices have forced many restaurants to shift their emphasis to the lunch-hour customer. Rising prices, shortages of skilled labor, low productivity, and the inability to utilize saving devices have placed the service intensive restaurant in financial straits.

The fast food franchise sector of the food service industry has experienced tremendous growth with more than 40,000 franchise outlets in 1969 accounting for $5 billion in sales. However, the fast food franchise sector also has been having difficulties. Among the causes are (1) the exploitation of the franchise concept by promoters long on marketing expertise but short on food service experience; (2) administrative and financial know how; (3) the acceptance of unqualified recruits in attempt to boost franchise sales and (4) the substitution of franchising for management talent. In the scramble of franchise expansion there has been much inept choice of sites. The neglect by the parent corporation of established franchisees has led to franchisee revolts and the withholding of royalties. Further, questionable financial practices and accounting systems have misled investors about the actual financial position of franchising systems.

With a tightening market and government regulation, reform in the fast food franchise sector can be expected. The author predicts that the current 80 percent - 20 percent division in the food service industry between fast food outlets and luxury establishments will continue to widen. Fast food establishments can be expected to make greater inroads into the retail food market.

50. Edward J. Smith. "The Quiet Revolution." Cornell Hotel and Restaurant Administration Quarterly, (May, 1962), pp. 7-13.

The rapid revolution in the food service industry is, like an iceberg, most powerfully felt beyond the eyes of the customer--in the kitchen and on the managerial levels. Changes in the restaurant industry are happening for numerous reasons; large restaurant companies, which are increasing in number and taking a growing percentage of the market, are in the best position to take advantage of these changes as they have better resources and more capital available.

The author draws parallels between the evolution of the grocery store and the restaurant industry. The grocery store has balanced high overhead and payroll costs by expanding sales volume, reducing customer services, and utilizing collective purchasing. The restaurant industry has only begun the fight to keep payroll and food costs down. Frozen prepared foods are one weapon several companies are trying in this battle. In John R. Thompson's experimental cafeteria, 75 percent of all sauces, entrees, gravies, and desserts are prepared in the company's frozen food plant. Customer reaction has been favorable, but food cost reduction can be ascertained only after the system is incorporated on a larger scale.

51. Roslyn Willetts. "Trends in Food Service." Food Technology, (May, 1973), pp. 99, 102

The two major trends in our society--(1) an increase in mechanical and electronic control, numbers-oriented record keeping and report filing, and (2) an increased awareness of individuality and ecology and a desire for organic food and informal living arrangements--will affect food service in the future. Work organization will increasingly offer workers greater responsibility and flexibility, and this will result in increased productivity and satisfaction. Computers will do routine work, particularly in the fields of food distribution and planning cyclical menus. The greater emphasis on ecology will occasion more trash recycling and air pollution prevention arrangements. Attention to more individualized nutrition and less organized eating patterns will result in more individual choices of, for example, raw or lightly cooked foods. Preparation of foods will be simplified, and new cooking methods and vessels will appear. Preparation in large-scale operations make optimum use of labor, resource and equipment. Low priced microwave ovens will revolutionize institutional feeding. And glorified self-service should increase. Portable buffet equipment will allow for varying the food or theme as will the change to many small dining rooms. Behavioral research and manipulation will open many possibilities, and as "consumers" of these new techniques, the public must stay ahead of the manipulators.

52. Authur C. Avery. "The Shape of Food Service to Come." Institution/Volume Feeding, 70 (May 1, 1972), pp. 83-95.

The author sketches the shape of the food service industry in the year 1986. The food processing industry will be completely automated. One individual will be capable of running a 10,000-meal-a-day commissary. Computer controlled, automated equipment will run the food processing operation from store room to clean up as well as take care of inventory control and the reordering process. In addition, the computer will handle all records, write all necessary business reports (including the annual report), forecast requirements, and perform all cost accounting duties.

The restaurant of 1986 will be completely automated. Customers will dine in a computer manipulated environment of aromatic and visual stimuli. They will stand before lighted menus picturing various entrees and punch out selections at order stations. Within 2 1/2 minutes they will be served the meal via conveyor belt running within the wall and stopping at the proper table. Dish bussing commences upon the customer's arising from his seat. Dirty dishes move onto a conveyor belt within an adjacent wall. The dishwashing process is completely automated. A 200-seat restaurant will require four employees and a manager. Avery notes that much of the technology of this futuristic design for 1986 is currently available and ready for implementation.

53. Alfred N. Califano and Allen Weiss. "The Turbulent Food Service Industry." Management Advisor, (July-August, 1972), pp. 38-43.

The food service industry has changed tremendously since mid-century. The industry has a tremendous impact on the economy as it buys almost 20 percent of all the food produced in the United States and accounts for purchases of over $700 million of equipment annually. In turn, the industry is heavily influenced by the state of the economy and changing life-styles. It is presently experiencing a profit squeeze caused by inflationary pressures and aggravated by consumer resistance to rising prices, rising labor costs, and painfully high restaurant rents.

The food service industry is turning to convenience foods as the principal solution to the profit squeeze. These foods require less skilled labor and less kitchen space. The systems approach answers the need for the coordination of all the required functions.

54. Mary Bralove. "Most People Have No Taste; It's Been Lost in the Process." The Wall Street Journal, (April 30, 1974), p. 1.

Food manufacturers have discovered that consumers have become so accustomed to mass produced, artificially flavored foods that sometimes real, natural flavors are found to be objectionable. Consequently, flavor designers are moving away from a fresh flavor bias. This raises the distinct possibility that food analogs and other manufactured foods may become increasingly acceptable.

55. Edward L. Perkins and William S. Penn, Jr. "Special Food and Equipment for the Food Service Industry." Food Technology, 24 (September, 1970), p. 970.

The food service industry is experiencing an industrial revolution, substituting production line labor for craft labor and substituting capital for labor. Extensive change is occurring on both the operational and structural levels. Structural change is primarily consolidation, both horizontal, and vertical, with an emphasis on the "systems approach." The major focus of the industry will be on convenience foods. According to a recent survey by Volume Feeding Management, up to 50 percent of the units are already using certain types of convenience foods and the outlook for the future is a steady increase. Most outlets combine convenience and conventional foods in some sort of "mixed system." Equipment in the next few years will probably see the advent of full-line suppliers, the present lack of which is hampering innovation and systems development. In their conclusion, the authors single out convenience foods, custommade products, and multiple packaging options as major forces in the future. They also see food technologists as playing a vital role in completing the food service revolution.

56. Carol Walek. "Monorail Meals." Food Technology, (September, 1972) pp. 30-34.

St. Elizabeth Community Health Center in Lincoln, Nebraska, has changed the traditional health-care feeding for its 208-bed unit by instituting Monorail (an automated cart transport system), an assembly-line-type kitchen, and galleys on each floor equipped with microwave ovens, roll-in refrigerators, and other necessary appliances. In the main kitchen, food is prepared, portioned, wrapped, and quick frozen. On the day of service, appetizers, salads, and desserts are prepared. All items are assembled on trays and transported to floor galleys where the final preparations are made. Utensils and carts are cleaned and sterilized before re-entering the kitchen.

This system provides a wide range of selections even for patients on restricted diets. It takes only 45 minutes to prepare the meals for the patients on an entire floor. And food costs have remained as low as in the more traditional systems--approximately 50¢ per meal. The quality and variety of food available at any hour of the day is seen as an improvement by both patients and staff.

57. Betty Ronan. "A 'Cooking Street'--Is It a Possible Food Preparation System?" Journal of the American Dietetic Association, 63 (October, 1973), pp. 417 - 418.

One German equipment company has developed a "cooking street," a line-up of high volume durable cooking equipment which is totally automatic except for the loading of bulk raw food. The arrangement of the equipment (deep-fat fryer, steamer, water cooker, and broiler) is variable, and it is available in two sizes. This system offers efficient use of kitchen personnel--two workers can man five pieces of equipment and in one institution 5,000 guests were served by a staff of nineteen. The system may be used to prepare food for immediate service, in which case it is automatically transferred to heated containers and conveyed to the distribution point; or it may prepare food for freezing, to be reheated later, often at a "satellite location." This seems to be the trend in Germany. After cooking, the food is automatically weighed into steamtable pans, covered, quick-frozen, and stored.

II

FOOD PROCESSING AND PREPARATION EQUIPMENT AS IT SHAPES THE FUTURE OF FOOD SERVICE

by

Frank W. Schmidt, Ph.D.

and

Stephen Bartlett

FOOD PROCESSING AND PREPARATION EQUIPMENT
AS IT SHAPES THE FUTURE
OF FOOD SERVICE

Introduction

The operation of food processing and preparation equipment is primarily governed by the rates at which heat and mass can be transferred to or from food. Therefore, it is appropriate to include with this paper a brief but technical discussion of the basic modes of heat transfer-conduction, convection, and radiation. Since the balance of the paper is much less technical, however, we have chosen to place this discussion of heat transfer modes in an Appendix. In addition, we have also included a Glossary of terms normally associated with heat transfer and used in this paper.

We begin with a discussion of past, present, and future research activities in heat transfer, placing particular emphasis on areas that are of specific importance in food processing and preparation. Then we review the equipment already available. In our conclusion, we predict the impact of engineering technology on future trends in food preparation and processing equipment with particular reference to those areas that require additional research.

Research in Heat Transfer

During the past 30 years, an extensive research effort has been undertaken by universities, industries, and government laboratories to further an understanding of the basic phenomena governing nearly all aspects of fluid mechanics, and heat and mass transfer. A summary paper and a projection of future trends has been presented by Sabersky (41). A great number of these research activities focused on problems associated with the aerospace and nuclear power industries where a precise knowledge of these phenomena is essential. Topics of particular interest to the food industry include

1. Property Evaluation. Standardized tests have been developed for the determination of the thermal conductivity, thermal diffusivity, and specific heat of various food substances, and the values of these properties have been published in the technical literature. Extensive work has also been devoted to a determination of the radiation properties of surfaces. In fact, there is considerable interest at present in the determination of the dielectric properties of foods because of the increasing use of micro-wave heating.

2. Prediction Techniques for Rates of Heat Transfer. The accuracy of the prediction of the ratio of heat transfer for complex as well as simple situations has greatly increased in the past few years. Part of this improvement can be attributed directly to

the availability of more accurate thermal property values, discussed in Item 1 above. Significant improvements have also been made in our ability to predict the values of the convective film coefficients for complicated flow systems, but more research is still needed in both the areas of forced and natural convection turbulent flows. Although more sophisticated analytical techniques have been developed, the major contributions can be attributed to the development of numerical techniques for the solution of heat transfer problems and the use of the digital computer in performing the calculations. The application of these techniques for conduction heat transfer are well documentated in the technical literature, and they are currently being developed and refined for application in the solution of fluid flow and convective heat transfer problems. These numerical techniques thus enable heat transfer rates to be determined in complex geometries and with variable thermodynamic properties, conditions which are often encountered in the commercial food industries.

3. Simulation of Processing Equipment. In food processing equipment, several different modes of heat transfer occur simultaneously, many times when several different fluids are present. Examples of such units are heat exchangers, evaporators and condensers. To optimize the design of these units, numerical simulation procedures have been established that help determine the equipment characteristics at off-design operating conditions and its response to transient changes in the operating parameters.

4. Instrumentation. Items 1-3 have dealt mainly with the prediction of rates of heat transfer and the performance of heat transfer

equipment. An evaluation of accuracies of these predictions can be obtained only through a comparison with experimental results. The development of devices for measuring temperature, fluid velocities, and heat flow as well as the thermal properties noted in Item 1 has been rapid. The aerospace and nuclear industries have been particularly concerned with securing accurate remote sensing devices, as well as data acquisition and analysis systems. Stable electronic packages that process signals from thermo-couples and thermisters for temperature measurement, and hot film, hot wires, and laser Doppler anemometers for velocity measurements have assisted greatly in the design of experimental studies.

Basic research into the fundamentals of heat transfer has resulted in the introduction of many new pieces of equipment. The microwave oven and the heat pipe are just two examples of equipment that will make a considerable impact on the food preparation industry in the future.

Microwave ovens have been commercially available for several years. Their energy is generated by a magnetron tube and directed into the oven's heating cavities. The rapid reversal of the high frequency field causes electrically polarized molecules in the food to oscillate, resulting in molecular friction and heating. The key to effective design and operation of microwave oven is to exclude all materials that tend to absorb microwave energy from the oven cavity, other than the food to be heated. The temperature distribution in the food will not be uniform because of local variation in the di-electric properties; thus local hot spots will occur in the food. These hot spots can result in irreversible damage to the food at these location. (Microwave ovens are discussed in more detail on page 93.)

The basic heat pipe is a closed container which contains a capillary wick structure and a small amount of vaporizable fluid. A sketch of a heat pipe unit is shown in Figure 1. The unit consists of a heating section where the fluid is vaporized, a cooling section where the fluid is condensed, and a wick structure which transports the fluid from the cooling end to the heating end. Extremely high rates of heat transfer are obtainable with the heat pipe, and the surfaces of the units remain at an essentially uniform temperature. The value of the temperature is controlled by the selection of the fluid and its operating pressure.

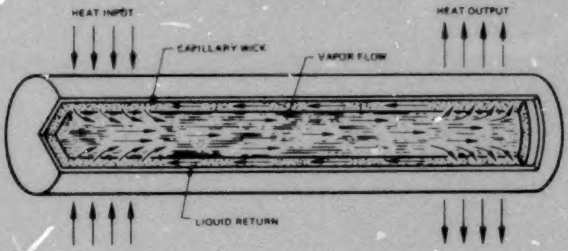


Figure 1

Basic Heat Pipe Configuration (21)

Food Processing and Preparation Equipment

A discussion of equipment currently available in the food processing and preparation industry follows here. We also intend to mention the equipment needed for the storing and thawing of food.

Freezers and Refrigerators

Freezing and refrigerating food products have been predominant means of food preservation and storage for many years now. With the advent of central commissaries and food satelliting systems, however, freezing and refrigeration are being applied more and more in conjunction with the food preparation industry. Refrigeration and the various types of freezing can be classified into two categories: "initial" and "holding." Initial freezing takes food from its fresh or prepared state to its frozen state, after which it is held in freezers. The various methods used to accomplish this process are discussed below, along with the advantages and disadvantages inherent in each freezing method.

Plate freezing. This method of freezing has been commonly used for many years with few changes. The refrigeration equipment is composed of an evaporator, where heat is transferred to the refrigerant; a compressor; a condenser, where the heat is ejected to the surroundings; and an expansion valve. The evaporator is located in the walls of the refrigeration chamber and has the lowest temperature in the cycle. Plate freezing is a very slow method of freezing because heat must be conducted outward through the product, then transferred by convection through the surrounding air to the refrigerant-carrying coils located within the chamber walls. For this reason, its popularity as a means of initial freezing is decreasing in favor of more modern, rapid methods. Plate freezing is still widely used, however, for holding frozen foods because it is simple and relatively inexpensive.

Although there have been no dramatic changes in the plate freezing system, the units on the market now are much more sophisticated than their predecessors. New refrigerants, better insulation, and more efficient evaporator and compressor designs have reduced the amount of room required in a cabinet for the equipment thereby allowing more freezer space for a given outer envelope volume.

When using these units for holding, one must take precautions to insure that the equipment is not left without power for a significant period. Many of the new units are equipped with high-temperature sensors, telephone dialing units, and auxiliary power supplies that can be switched automatically or manually to provide electricity for the freezer.

Blast freezing. Blast freezing, along with other systems yet to be described, has been designed to accomplish initial freezing. This method utilizes a mechanical system with enclosed refrigerant to provide low-temperature air, generally -35 F, to the freezing chamber at a high velocity in order to speed the transfer of heat from the product. To provide even temperature distribution and maximum exposure of the product, blast freezing utilizes a series of baffles.

Some of the advantages of blast freezing follow here:

1. High density products with a large physical plane geometry can be frozen in a short time.
2. Packages of various sizes can be processed, even when intermixed.
3. The temperature of the air stream can be maintained at -35 F so that the introduction of warm products will not raise the temperature of the chamber.
4. After the initial investiment for equipment and installation, operating costs are nearly constant, except for the cost of electricity. (The higher the volume processed, the lower the unit cost for freezing.)

There are some disadvantages to this method, however, and they follow:

1. A large amount of physical space is required for blast freezing installation.
2. Its large number of relays, interconnects, and other electrical systems can lower reliability. If one component malfunctions, the entire system fails.
3. Leaking packages can cause a mechanical malfunction. Careful control of the production line must be maintained to eliminate "leakers."
4. Cleaning is difficult. USDA inspectors, constantly on duty in major food plants, may insist at any time that the freezer and conveyor be cleaned. The freezer cannot be shut down during operation without the possibility of food spoilage, so cleaning is an expensive process involving indirect labor, special

anti-freeze cleaning solvents, and the possibility of inconvenience and waste.

Cyrogenic freezing. This system freezes a food product by direct contact with a liquefied gas, usually nitrogen. The liquid nitrogen is stored at a temperature below its boiling point of -320 F and is vaporized by heat absorbed from the food. The rate of heat transfer is greater than in a blast freezer because the transfer medium is a liquid rather than a gas and a change of phase occurs.

In an operating unit, which is usually a continuous, conveyor-fed device, the product passes through a chilling zone into the freezing zone where it is sprayed with liquid nitrogen. It then passes through an equilibration zone, to allow temperatures within the product to equalize, before leaving the unit. The chilling zone is created by circulating the cold, vaporized nitrogen through that area of the chamber.

The use of liquid nitrogen as an expendable refrigerant has become more practical since its cost has decreased greatly. Consequently the demand for liquid oxygen has increased tremendously in the past decade: the space program uses it as a rocket propellant. The steel industry has developed new processes requiring pure oxygen. That liquid oxygen is obtained from air, yielding as a by-product about three times as much liquid nitrogen.

These are the advantages of cryogenic freezing:

1. Little space is required for its installation as compared to a blast freezer.
2. Disassembly and cleaning requires relatively little effort.

3. Dehydration of the product during freezing is minimal--less than 0.44% of prefrozen weight.

Its disadvantages follow:

1. Freezing costs vary according to input rate, product density, and product geometry. Costs are lowest with a high input of products of a single size and shape.
2. Water vapor in the air entering with the product causes frost build-up which hinders the operation of bearings, shafts, and conveyors.
3. Certain products and packaging materials are not compatible with cryogenic freezing. Food packaged in plastic pouches, for instance, cannot be frozen by this method because the plastic cannot withstand the -320 F temperature. Material in pans must have the cold penetrate the pan before freezing begins. Thus, if possible, the product should be frozen before being packaged. Some products can be overfrozen and become brittle, and since many foods can be acceptably frozen at -5 F or -30 F, a lower freezing temperature is wasted.
4. After the freezer is cleaned, it must be dried thoroughly before using. (But forced-air units may be installed to speed the drying.)
5. If production stops while the freezer is operating, some liquid nitrogen is constantly expended, which costs money. If the freezer is shut down, restarting requires considerable time and a good deal of liquid nitrogen to chill the unit.

Immersion freezing. Previously immersion freezing was accomplished by immersing the product in a mechanically refrigerated brine solution. Food was protected from the brine by plastic wrapping or a metal container. The newer equipment, however, uses liquid Freon as the refrigerant and operates in a temperature range of -22 F to -35 F. Because the product comes directly into contact with the cold liquid refrigerant, similar to cryogenic freezing, the rate of heat transfer from the product is greater than in plate or blast freezing.

Extensive studies have been conducted to investigate the safety of allowing Freon to come into contact with food, and the method has received approval from health authorities.

Here are the advantages of immersion freezing:

1. Little refrigerant is expended as compared with liquid nitrogen. The higher vaporization temperature of Freon allows for economical condensation and reuse. In various plants now operating, more than 99% of the Freon vaporized during freezing is reclaimed.
2. Moisture is kept out of the freezing chamber by using the "heavy" Freon vapors to displace incoming air. Any water vapor which does enter is suspended in the Freon and removed when it is recycled.
3. Because the freezer operates in the -35 F temperature range, there are no adverse effects on packaging materials.
4. Based on actual operating figures, freezing costs are between one-fourth and one-third those for liquid nitrogen freezing.

The disadvantages of the Freon freezing system follow:

1. Initial investment for the unit is high, approximately twice

the cost of the liquid nitrogen system.

2. This method is still being tested for a wide range of food products. Therefore, not all applications and shortcomings of the system are known.

Individual quick freezing (IQF). IQF is not a different equipment system, but rather a new approach to freezing certain products. Items of small individual size, like peas, strawberries, and shrimp, are loaded in loose form. As they pass through the freezer, they are frozen individually, rather than in a large block or package. Blast, cryogenic, or immersion freezing can all be used for this process. Because of the small size of the product, each individual piece freezes rapidly. Faster freezing results causes smaller ice crystals to form within the product, thus less cellular damage occurs than the large crystals, formed during slow freezing, cause. This means that product texture improves and drip loss during thawing lessens. Studies have shown that blast freezing gives superior results to plate freezing, with cryogenic and immersion freezing being better yet (13).

Thawing Equipment

Because large quantities of many foods can be preserved for long periods, freezing has become one of the most widely used packaging methods of our time. But all too often, considerations of how to thaw frozen food have been ignored, negating any gains from the improved preservation freezing provides. The old method of leaving frozen foods on a counter top until they thaw is no longer acceptable, either from the standpoint of quality retention or sanitation. This is particularly true of the larger packages in which food is now being frozen: by the time the material in the center of the package has thawed, the outside has been at or near room temperature for a considerable time. To overcome this problem, various types of units are available to thaw food quickly and safely. These include conventional tempering cabinets and newer microwave and vacuum thawing systems.

Conventional tempering cabinets. Conventional thawing utilizes standard refrigerators or coolers to raise the temperature of frozen products for subsequent processing or preparation. Although this method keeps the food safely refrigerated, it can be slow and may require as long as three days for complete thawing, depending on the product type and size. It also requires considerable space devoted to chilled storage. Several manufacturers have developed refrigerators that serve the dual purpose of standard refrigeration and thawing (20). By adding such accessories as auxiliary heaters and fans to increase air movement, thawing time can be reduced to between eight and twelve hours while a safe average refrigerator temperature of around 40 or 45 F, which keeps food below 40 F, is maintained.

Microwave thawing systems. This system uses microwave power to raise the temperature of large blocks of a frozen product. Microwaves are especially effective because they penetrate the interior of the package, rather than relying on heat conduction from the surface to the center of the block. This method is generally applied in a continuous type system where the degree of thawing can be controlled by conveyor speed or the microwave power level. One manufacturer claims that

60-pound blocks of beef can be tempered from -10 F to 27 F in approximately five minutes with this system (37).

Vacuum thawing systems. One manufacturer has developed a unit that uses heat released by condensing steam to warm a frozen product (2). Because of the low pressure within the chamber, the steam remains at a temperature of 68 F to 77 F, instead of the 212 F boiling point. This method thaws food quicker than conventional means and may be suitable for tempering food for immediate use. But prolonged exposure to the temperatures it uses could cause food quality degradation.

Both the microwave and vacuum systems are faster than the conventional means, thus they are more convenient and reduce the large space otherwise required for tempering rooms. Application of microwaves is faster than vacuum thawing and results in a more uniform temperature distribution throughout the product. This is especially desirable because certain processes, like slicing, dicing, and grinding, require the food to be at a specific temperature for the best results.

Ovens

Ovens are the equipment most often used to heat food products, both in the food service industry and in home cooking. They are used primarily to cook such items as meats, casseroles, and bakery products, and they are also used to reconstitute modern convenience foods. For years, the only ovens in widespread use were the electrically heated or gas-fired free-convection ovens. However, the demand for reduced processing time and higher volume production has forced operators to consider alternative heating methods. Two of the most promising new pieces of equipment available are forced-convection oven and the microwave oven.

Forced convection ovens. Forced-convection ovens, referred to usually as "convection ovens," are really only a slight modification of the standard free-convection ovens. A recirculation loop is added wherein a fan forces reheated air through the cooking chamber at a high velocity. The increased velocity reduces the thickness of the air film surrounding the product to be cooked and allows more heat to be transferred to the product's surface since its convective heat transfer coefficient is increased. As the air circulates, it absorbs moisture from the product, dehydrating it somewhat. But because the air is recirculated rather than being exhausted, it soon becomes saturated and will not absorb any more moisture.

The higher rate of heat transfer decreases cooking time as much as 50 percent in some instances, and allows cooking at lower temperatures, which reduces drip loss, scorching, and fuel consumption. These large reductions in cooking time occur only if the block of food being heated is not too large. For a thick block, conduction of heat through the product becomes the limiting factor, not the rate at which heat is transferred to the surface. In this instance, heating time will usually be reduced about 10 percent.

The major shortcoming of convection ovens seems to be its uneven heat distribution. Because of varying oven loads and possible tray configurations, temperatures can vary as much as ±10 percent throughout the cabinet, despite the use of vents and baffles to combat this problem. One manufacturer claims an ability to control the temperature

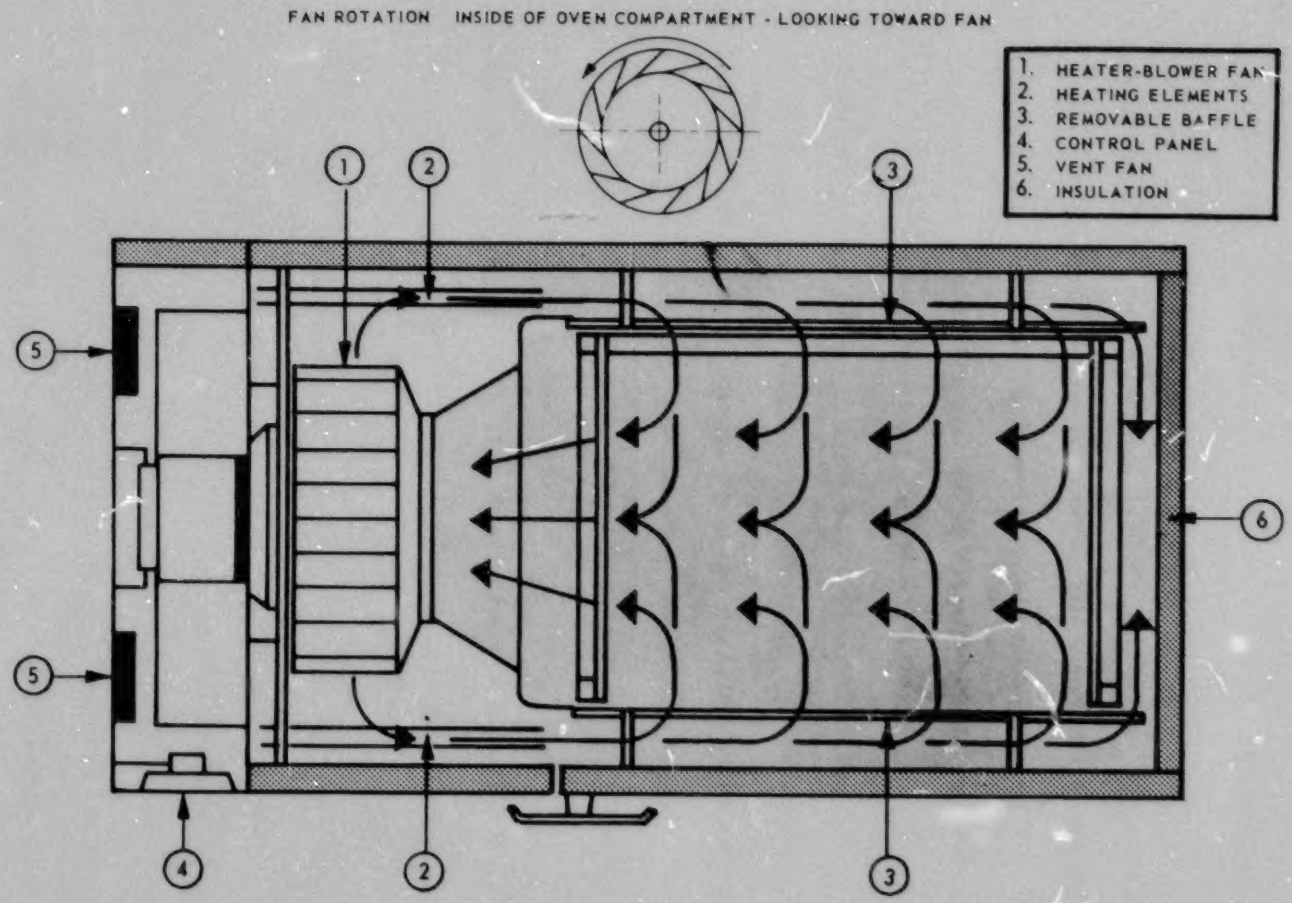

FAN ROTATION INSIDE OF OVEN COMPARTMENT - LOOKING TOWARD FAN
1. HEATER-BLOWER FAN
2. HEATING ELEMENTS
3. REMOVABLE BAFFLE
4. CONTROL PANEL
5. VENT FAN
6. INSULATION
①
②
③
④
⑤
⑥

Figure 2

"Crown X" Forced Convection Oven (7)

to within ±5 F in his unit. He does this by blowing air first from one side, then the other, rather than constantly from the back as is done in most American-made units. European manufacturers have been using the side-fed system for years, allowing them to gang multiple ovens side by side without the installation of additional heater/blower units (51).

Forced-convection ovens are gaining rapidly in popularity. They are being installed in most new operations and are replacing free-convection ovens in many existing facilities. (Figure 2 depicts a typical forced-convection oven.)

Microwave ovens. When microwave ovens were first introduced, they were hailed as the future mainstay of the food service industry. They haven't yet fulfilled this prediction, but they have been increasing rapidly in popularity during recent years and will probably continue to show increased use in the future as more of their problems are overcome.

Microwave ovens transform electrical energy into microwaves by means of electronic equipment. The microwave frequencies which have been found most suitable for cooking are 915 and 2450 megacycles. The microwaves penetrate the product and are absorbed, releasing their energy to the molecules of food and quickly raising the product's temperature. Because the energy is deposited throughout the product, rather than just on the surface of the food and because the heat need not be conducted to the interior, cooking time is reduced substantially. Microwave cooking can be applied to batch-type as well as continuous operations.

A distinctive characteristic of microwave ovens is their use of energy. In other ovens, the product, the air within the cooking chamber, and the walls of the chamber all absorb heat. In a microwave unit, all the energy heats the food. Air passes microwaves without absorbing them and metal walls reflect microwaves without absorbing them. Unfortunately, the electronic systems that convert electricity into microwaves are only 30 to 50 percent efficient in the sizes and power levels now in use. Most units now available require about 3 kw input power and have an output of approximately 1 kw. But one manufacturer of microwave power modules has developed a high-power unit which he advertises as 72 percent efficient (22). With an output of 425 kw, this module could be applied in operations involving extremely high volume production.

Microwave ovens aren't in the widespread use initially predicted for them because of problems, some real and some only imagined, encountered during development. An understanding of these problems and what is required to overcome them is necessary in order to draw predictions about future applications.

The first shortcoming of early units was uneven heat distribution. Because of the extremely regular shape of the standard rectangular cooking chamber, standing waves caused "hot spots" within the product. Modern units use rotating fans called ("stirrers") or reflective grids to disperse the waves evenly throughout the oven cavity.

Early literature also reported the formation of undesirable chemicals as well as ions and free radicals which react to form secondary products. In these early ovens, however, spark formation and leakage of x-rays from the microwave generator were not uncommon.

Energy released by these means is sufficient to cause ozone formation or to break chemical bonds. Recent studies have shown, however, that microwaves transmit too little energy, by several orders of magnitude, to be directly responsible for any chemical changes (34). But in a localized "hot spot," chemical reactions may occur which might not be desirable at the indicated mean temperature of the product. These thermally-induced effects account for most, if not all of chemical changes observed in microwave heating.

Even when the distribution of microwaves is uniform, "hot spots" can occur due to non-homogenous or irregularly shaped products. Most biological materials are composed of layers or striations of muscle, fat, and connective tissue or, in the case of fruits and vegetables, flesh, woody pulp, and seeds. Each of these has a different dielectric property. This variation can cause localized heating in a material which makes up an otherwise insignificant portion of the total product.

Moreover, particular care must be taken when heating products that have been previously frozen since microwaves affect water at a much higher rate than ice. To counteract this problem, a system of pulsed microwave application has been devised. Energy is applied for a short time, then the product is rested to allow heat to conduct evenly throughout the food. This adjustment not only allows heat to dissipate from any high-temperature areas, but also allows conduction inward, where the material is less affected by the microwaves directly.

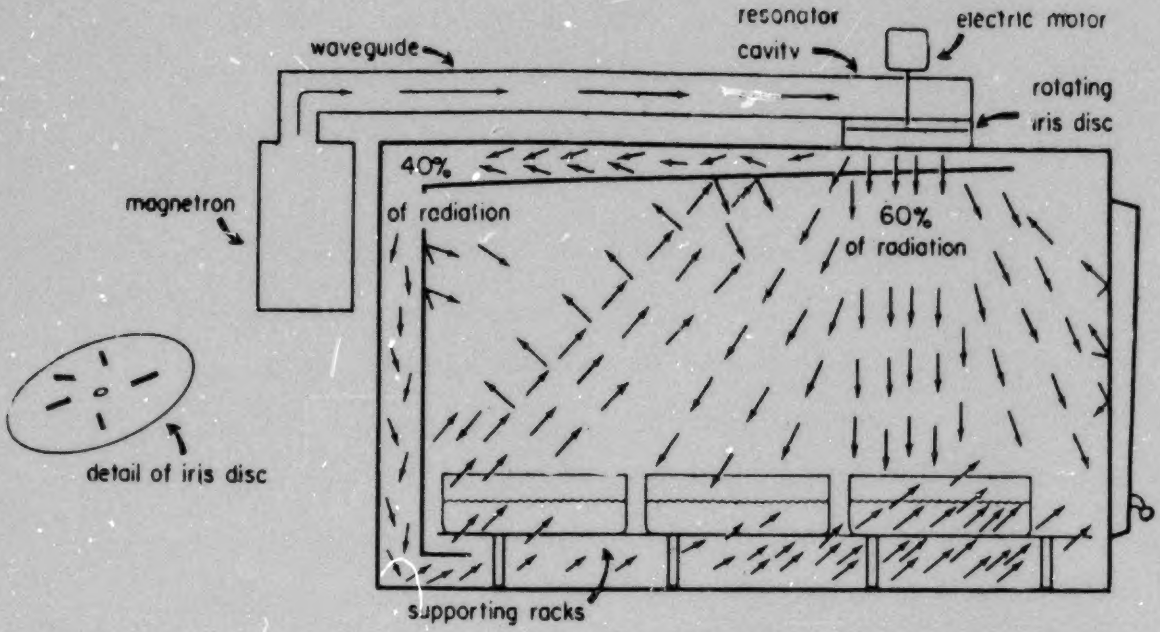
Because microwaves deposit their energy evenly throughout the product, the outer surface receives the same treatment as the remainder of the food. In other words, there are no surface effects like charring, browning, or carmelization. Consumers have come to expect surface treatments on many of their foods, so many products cooked by microwaves are not completely acceptable even though they are thoroughly cooked. For this reason, other means of cooking are often used in conjunction with microwaves. Steaks and chops may be seared on a grill prior to microwave cooking while bread or cakes are cooked at high temperatures for a short time in another type of oven, then finished by microwave power. White bread and rolls have a surface texture and color resembling brown-and-serve rolls, with no surface browning or glaze, after microwave baking. However, satisfactory results have been obtained with dark breads, such as whole wheat and rye, and dark colored cookies using microwave processing exclusively (29).

Another problem when cooking with microwaves occurs with the use of metal pans. Microwaves are reflected by the metal, thus heat does not penetrate through the bottom or sides of the pan. Most of the ovens in production today have a circuit which will shut off power to the oven if there is excessive microwave reflection within the cooking cavity. New temperature-resistant plastics that pass microwaves have been developed and offer great promise of a solution to the reflection problem. The ability of metal foils to block microwaves has been utilized to allow selective heating of pre-plated food. Perforations in the metallic shield allow varying degrees of microwave penetration; certain items are heated, some thawed, and others remain frozen, as desired. Metal shielding on the sides of flat baking pans prevents the "edging effect," overbaking of edges and corners due to microwave application from top, bottom, and sides simultaneously. (A typical microwave oven is schematically depicted in Figure 3.)

Combination ovens. Combining another means of cooking with microwaves takes advantage of rapid, uniform microwave heating while compensating for the shortcomings of a pure microwave system. Supplementary processes like grilling, frying, roasting, or baking can be applied before or after microwave processing, as discussed previously. In fact, units are now available that combine heating methods in one piece of dual-purpose equipment.

Excellent cooking results have been obtained with microwave-convection ovens in which the two processes are applied simultaneously or separately (23). This test also studied the feasibility of using special aluminum foil pans as containers during cooking. The pans were modifications of standard aluminum foil containers in which food is commonly packaged. To allow microwave penetration from the top, the lids had a pop-out window which, when removed, exposed a see-through oven-service film through which microwaves could pass. The underside of the pans were black-coated to improve heat transfer to the product through the bottom of the container. The lid also served to retain moisture in the container, raising the interior temperature and minimizing food dehydration.

Several microwave units for domestic use have been manufactured with resistance heating elements at the top and bottom of the oven to provide radiant heat. The resistance elements also serve as microwave antennas to transmit energy produced by the microwave power modules. The addition of a simple blower would provide forced-convection heat-


resonator cavity
electric motor
waveguide
rotating iris disc
40% of radiation
60% of radiation
magnetron
detail of iris disc
supporting racks

CROSS-SECTION VIEW THROUGH ONE END of microwave oven showing wave pattern through three water loads at one instant

Figure 3

A Microwave Oven (15)

ing and could further improve heat transfer to the product being cooked.

The use of a steam atmosphere in conjunction with other heating means like radiation or convection has been applied in several units. The additional moisture helps prevent undue product desiccation and gives a surface glaze to certain baked goods. A steam environment is particularly desirable in certain microwave applications like vegetable blanching. Microwaves heat the interior, but evaporation cools the surface of the product. Moisture must be maintained in the environment to heat and blanch the surface.

One manufacturer makes use of refrigerated air in infrared and combination infrared-convection ovens (28). Temperatures within the chamber can be as high as 600 F to 850 F, easily scorching the surface of the product. The refrigerated air reduces the scorching while it allows maximum penetration of the infrared rays. But expending energy to heat and cool a product simultaneously would seem to be questionable efficiency, particularly if equivalent results can be obtained by other means.

Other oven types. Other types of ovens, like the infrared and quartz plate ovens, are not used as widely as those already mentioned, nor are they increasing in popularity as quickly as convection and microwave ovens. Since there is little information on them in current literature, we offer no comments on their specific characteristics and their practical food service applications.

One method for reconstituting prepared foods that deserves mention is the Integral Heat System (45). This system seems to be competitive with small microwave kitchenettes used in hospital wards (25).

Specially designed dishes in which food is cooked and served are made in two parts: the outside shell is a high-quality polymer, while the inner dish is porcelain ceramic with carbon resistor material fused to the underside. Electricity is conducted from the rails of the holding cabinet through electrodes in the outer shell to the resistor. There it is converted to heat and conducted to the food. No heat is wasted through the heating of the air in the oven cavity or the walls of the cabinet.

Standard 10- to 12-oz. hospital meals can be reconstituted from the frozen state in 18 to 20 minutes, compared to the 35 to 40 minutes required by convection ovens. Already thawed meals can be heated in approximately half the time of frozen foods. Food can be held in its heated state if convenient for the recipient, making this system ideal for hospitals and in-flight airline food service.

Fat Fryers

Deep fat fryers cook food by immersing it in liquid cooking fat which is heated through some type of heat exchanger. The source of heat can be either electricity or gas. The hot fat has a higher heat capacity than air and provides a high convective film coefficient. This characteristic provides a faster rate of heat transfer than a gas like air under free convection conditions.

Though the basic concept of deep fat frying has not changed over the years, refinements of the equipment provide for more convenient operation and higher quality products. Units now available have more accurate thermostats and timers built in for better process control.

Automatic basket lifts terminate cooking after a preassigned length of time to prevent overcooking. Most designs include a "cold zone," a space beneath the heating tubes which does not reach as high a temperature as the fat above the tubes that cooks the food. Food particles drop into this area of cool fat (or water in some equipment) and do not carbonize as rapidly. This reduces the rate at which the fat breaks down and becomes unsuitable for further use. In addition, to prevent fat breakdown, some systems have built-in equipment for filtering the oil. Others must use separate units designed for this purpose.

A recent development in this cooking method involves a pressurized container during cooking. At the beginning of the cycle, the vat is covered and sealed. As the food is heated, internal moisture is turned into steam which increases the pressure inside the vat. Pressure forces the fat against the product and increases the rate of heat carried into the food. The moderate convection caused by heating the fat agitates the product providing equal exposure of all surfaces to the cooking oil. Improved efficiency of heat transfer combined with sealing in the hot vapors means the oil can be used at lower temperatures. This lengthens the life of the fat and reduces fuel consumption.

Up to 75 percent of the original moisture of the product is retained during pressure frying, as opposed to approximately 50 percent retained in open vat frying. Moreover, proper frying results in as little as 4 percent fat absorption.

To show how fat frying can be used on products not generally associated with this type of cooking, a recent demonstration used cuts of U.S. choice steak. The resulting steaks were grease-free and cooked to the specified degree of doneness. They were considered by several tasters to be almost indistinguishable from U.S. prime meat. In another test, pressure fried steaks were judged to be more tender than broiled steaks (34).

Cookers

Steam cookers operate on the principle that heat can be applied more efficiently through a moist medium than a dry medium like air. Modern steamers perform much the same functions as their predecessors, but they have been updated to meet modern standards of convenience and quality. In the past, steam was supplied to individual units from a central steam generator. If the central unit failed, all the kitchen equipment that required steam stopped. Equipment now available not only connects to steam lines, but can also operate from self-contained steam generators. These generators can use gas or electricity for steam production and operate quietly without the hammering and hissing associated with steam generation. Typical units utilizing steam heat are steam jacketed kettles, low-pressure and high-pressure steamers.

In a steam jacketed kettle, steam is introduced into a hollow shell surrounding the cooking vat. Condensation on the inner wall transfers heat from the steam through the wall to the food. The higher the pressure of the steam, the higher its temperature and the more heat it will transfer to the food. Kettles can be equipped with automatic scraper paddles to blend such items as gravies and sauces continuously during cooking. Some units have provisions for filling the jacket with cold water after cooking is completed to cool the product faster (44).

Low-pressure and high-pressure steam cookers allow steam to come in direct contact with the product to be heated. Low-pressure units operate at approximately 3 psi, providing steam at 220 F. This equipment can be used to reconstitute frozen foods if the packaging will prevent entry of steam into the package. High-pressure steamers supply steam at 15 psi and 250 F. They are widely used to heat frozen vegetables in open or perforated trays.

Due to certain shortcomings, steam cooking seems to be declining in popularity in the face of such new equipment as convection and microwave ovens. Although moist heat prevents dehydration, many items cannot be reheated this way because the moisture adversely affects product quality. Also, steam heating is slow compared to other cooking methods. And condensation resulting from hot steam coming in contact with the cooler product forms a film which resists heat transfer. Forced convection of the steam shortens reconstitution time, but not enough to make it truly competitive with other means. One user of steam equipment says that steam cooking is on its way out; microwave and convection ovens are what people are using (18).

An equipment system still under development is a heated water bath for reconstituting individual portions packaged in flexible plastic pouches. The primary requirement for this unit is a high rate of heat input into the water bath. The water must be kept at a rolling boil, even when several pouches are immersed in the bath simultaneously, because the only way to insure proper cooking is to control the length of time the product is immersed. Another necessary component of the system is a system of racks to keep the bags submerged and separate from one another to allow free water circulation. An automatic timing and retrieval system should also be included so the operator does not lose control of the heating time for any individual pouch. If "boil-in-bag" products continue to increase in popularity, commercial units of this type may soon be available.

Broilers

Broiling is the traditional way of preparing many of our most popular foods. Units now available are electric or gas-fired, and food service operators generally prefer the gas-fired equipment. The method of heat transfer used in broilers is radiation, either from electrically heated resistance elements or heated ceramics in the case of gas equipment. Heat is transferred to the surface and is conducted inward. A characteristic of broiling is that the surface is seared and the natural juices sealed in. Some new units are constructed so that the product is cooked on both sides simultaneously.

Most commercial installations are now using infrared broilers because of the high temperatures generated and the resulting increase in the rate of heat transfer. High-volume operations are making use of continuous-type equipment which requires only unskilled labor once the temperature and belt speed have been fixed for a particular product.

Char broilers with their open flames are used primarily as specialty equipment and to provide "atmosphere."

Holding Equipment

In the past, prepared food awaiting service was held in steam table pans to keep warm; or if the food was to remain chilled, it rested on a bed of crushed ice. Though some deterioration of product quality occurred during the holding period, this procedure remained acceptable for holding bulk pans of food, for example on a cafeteria serving line. The proceding is not practical, however, in such applications as hospital food service or when food is transported from a central commissary to a satellite location.

To overcome this problem, holding cabinets have been developed to maintain the food at an optimum temperature. These cabinets include three basic types: insulated, heated, and refrigerated.

Insulated cabinets. Insulated cabinets have no heating or cooling equipment built in, rather they prevent the temperature of the product from changing drastically once it is loaded into the cabinet. These cabinets are particularly useful when there is no power source available for heating or cooling while the product is in transit or at the location where it is to be consumed--for example, in a "meals-on-wheels" program or the feeding of large numbers of farm workers in the field.

Heated cabinets. These cabinets contain an electrically-powered heating source and may be either insulated or uninsulated. They are capable of holding temperatures from room temperature to as high as 200 F or 250 F, though ideal serving temperatures for most foods range between 160 F and 190 F. Many of the units now available actually house two separate holding containers in one cabinet. They are separated physically and have independent thermostats so that various foods may be kept heated to different temperatures.

Refrigerated cabinets. These cabinets resemble heated cabinets, but have self-contained cooling systems. Many are available with separate freezer sections in addition to refrigeration. Temperatures within the different sections can be adjusted within certain limits.

Heated and refrigerated cabinets are often transported in vehicles with special electrical circuits to provide power to the containers. They can also be plugged into standard outlets at their destination. Heated cabinets can be used for reconstituting pre-plated meals when food is being satellited from a central commissary to schools or hospitals, for example. All types of cabinets are designed to accept trays and pans of various standard sizes and depths.

Several manufacturers offer cabinets that can be switched from refrigeration to heating (6, 10, 13). This feature is particularly useful for reconstituting food that should be stored under refrigeration for a period of time. It also provides added versatility to high-volume operations, since it can be used in either mode, depending on the relative amounts of heated versus refrigerated food being held. It reduces the number of extra cabinets that must be maintained to compensate for variations in the type of holding method required.

Waste Disposal and Pollution Control

Recent public awareness of environmental abuses has caused American industry to re-examine its methods of waste disposal and pollution control. Food service operations have not escaped criticism and must now begin to solve those problems particular to their industry. Means of disposing of solid waste fall into three main categories:

compaction, shredding, and incineration.

Compactors. Particularly when they package the waste in plastic bags, compactors can cause the refuse to become less biodegradable. Recent studies have shown, however, that proper packaging and handling during final disposal minimize this problem (52). The biggest single advantage of compactors is that they reduce the volume of trash to be hauled away and the space required for storage between pick-ups.

Shredders. Shredders consume paper, plastic, cans, and bottles and chop them into small pieces. Like compaction, this process significantly reduces the volume of refuse. It also aids in subsequent reclamation of recyclable materials and makes non-recyclable substances more biodegradable.

Incineration. Burning refuse effectively eliminates the intermediate steps involved in other methods of disposal by destroying the waste products immediately. In many locations, however, incineration is not allowed, and where it is, strict regulations are in effect concerning emissions. Incineration is often the means of final disposal for non-recyclable materials processed by compaction and shredding.

The other ecological concern with which food service operators must contend is control of other emissions from their establishments. These can and often do include vapors from ranges, grills, and fryers, as well as from incinerators. Preliminary filtration of exhaust air from cooking areas is usually accomplished in one of two ways: The older method, still widely used, is to pass the air through a simple filter to remove grease. Formerly, the filters were used for a short time, then disposed of when they became too grease-laden to perform efficiently. Later filters could be cleaned by a washing in a standard dishwasher and reused thereafter. Newer filters consist of a series of baffles through which exhaust air passes at high speed pulled by an exhaust fan. Grease particles are thrown out of the air stream, collected in a grease trap, and disposed of. These filters remove more grease than the older types, reducing build-up in the ductwork. And they also retain less grease in the filter itself; both characteristics reduce the chance of fire.

The other system of preliminary filtration is more sophisticated and costly, but it can pay for itself in other ways. Exhaust vapors are subjected to a high-pressure water spray which cools the air below the condensation point of grease. The grease is carried away by the water into the sewer system. Because the exhaust air has been cooled, heavy-gauge ductwork and insulation formerly required may no longer be necessary.

A water spray can also be used with baffle-type filters to wash away trapped grease. These water sprays act as a fire barrier to prevent a fire in the cooking area from spreading to the ductwork. Many units incorporate auxiliary systems to extinguish fires on the cooking surface if the temperature sensed in the exhaust duct exceeds a preset limit.

Final processing of exhaust air is accomplished by electronic precipitators. They are also used to remove particulates from the incincerator exhaust gases. Electrically charged plates ionize particles too small to be filtered out by conventional means.

Filters and precipitators are able to keep emmissions from food service operations within limits prescribed by present laws. However, they may not be enough in the future. Operators say the number of complaints concerning objectionable odors is increasing steadily (1). This may become an even more difficult problem because the particles that cause the odors are not removed from the exhaust gas by filters or precipitators.(50)

Completely Integrated Systems

There is a food service system now in operation in Europe, and soon to be tried in this country, which represents the state-of-the-art today, and will undoubtedly serve as a model for high volume food service operations for many years. It utilizes a "Cooking street" of high-production, automated equipment for performing various types of cooking (38). The purposes of food preparation vary between different operations, but the pieces of equipment used are standard in all facilities. They include a steam cooker, a water cooker, a deep fat fryer, a grill, and a broiler. The equipment considered here is manufactured by the German-based NEFF company (10). This equipment represents, collectively, the most highly automated system of its kind. It is the type soon to be used in its first United States installation.

The Steam cooker. Fresh or frozen vegetables are loaded into the intake bin. They are conveyed by the automatic loading system to a loading drum which portions the product into perforated stainless steel containers for cooking. The containers are mounted on a motor-driven chain which can be adjusted to provide between six and sixty

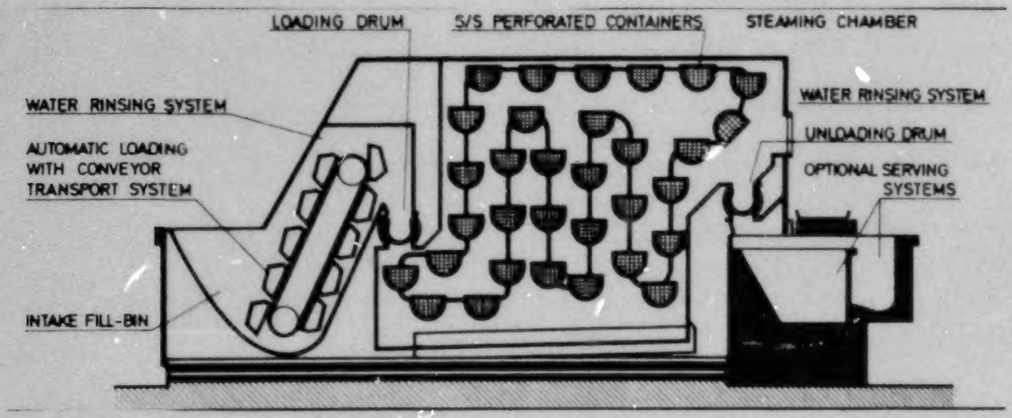

LOADING DRUM
S/S PERFORATED CONTAINERS
STEAMING CHAMBER
WATER RINSING SYSTEM
AUTOMATIC LOADING WITH CONVEYOR TRANSPORT SYSTEM
INTAKE FILL-BIN
WATER RINSING SYSTEM
UNLOADING DRUM
OPTIONAL SERVING SYSTEMS

Figure 4

NEFF Steam Cooker (10)

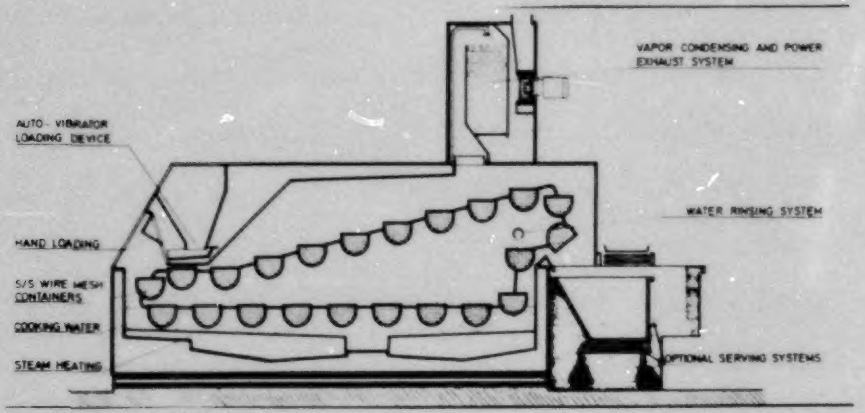

VAPOR CONDENSING AND POWER EXHAUST SYSTEM
AUTO- VIBRATOR LOADING DEVICE
HAND LOADING
S/S WIRE MESH CONTAINERS
COOKING WATER
STEAM HEATING
WATER RINSING SYSTEM
OPTIONAL SERVING SYSTEMS

Figure 5

NEFF Water Cooker (10)

minutes of product exposure to the steam atmosphere. At the end of the cycle, the food is transferred to an unloading drum and from there to a built-in receiving bin or a portable, tilting kettle which can be heated or not, as required. Depending on the type of product and cooking time required, the steamer can cook from 400 lbs. to 900 lbs. of food per hour.

The water cooker. The food to be cooked is loaded into wire mesh containers by hand or by means of a vibrator loading device. The containers are passed through water heated to just below the boiling point by steam injection. When the cooking is completed, the product is rinsed with tepid water and unloaded into the desired type of serving unit, either stationary or mobile. Cooking time can be varied from as little as four minutes to as much as forty minutes. The water cooker can produce 500 lbs. of rice per hour with an average cooking time of 20 minutes; 600 lbs. of pasta per hour with an average cooking time of 15 minutes; or 1800 hard-boiled eggs per hour with a cooking time of six to ten minutes.

The deep fat fryer. This piece of equipment is similar to the water cooker in design and operation, but it uses cooking oil heated by electricity. The output of this unit is approximately 1700 portions per hour.

The grill. Products to be cooked are placed by hand on the grill, then moved across the surface by a series of stainless steel bars mounted to a motor-driven chain. The speed can be adjusted to provide from three to thirty minutes of cooking time. At the center of the grill, the product is automatically turned over by a "flipper"

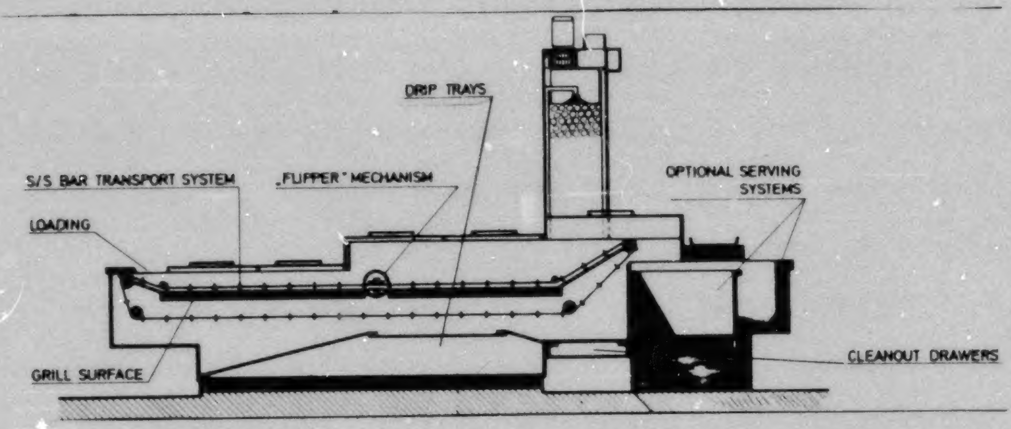

DRIP TRAYS
S/S BAR TRANSPORT SYSTEM
„FLIPPER" MECHANISM
LOADING
OPTIONAL SERVING SYSTEMS
GRILL SURFACE
CLEANOUT DRAWERS

Figure 6

NEFF Grill (10)

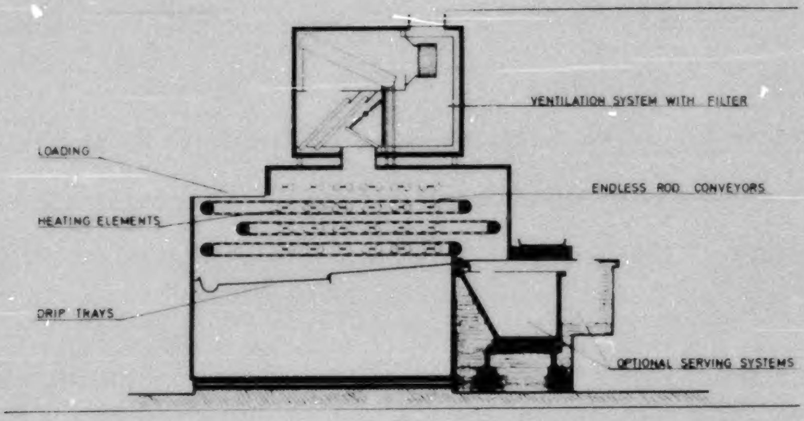

VENTILATION SYSTEM WITH FILTER
LOADING
ENDLESS ROD CONVEYORS
HEATING ELEMENTS
DRIP TRAYS
OPTIONAL SERVING SYSTEMS

Figure 7

NEFF Broiler (10)

mechanism to provide even cooking on both sides. The food is forced up an incline before unloading to allow grease and oil to drain off. The grill can also be used as a band fryer by using a layer of cooking oil up to 1½ inches on the grill surface. Output of such items as steaks, chops, grilled sandwiches, pancakes, and hash brown potatoes is between 1500 and 3000 portions per hour, depending on the cooking time required.

The broiler. Items to be broiled are placed by hand on a rod conveyor belt. They are transported through infrared heating zones with heating elements above and below the belts. The product drips from the first belt to a second one, and finally to a third belt. Thus, the food passes through the heating zone three times before being unloaded into the desired receptable. Cooking time can be adjusted between 2½ and 25 minutes. Steaks, chops, hamburgers, sausages, and chicken are produced at the rate of 800 to 1700 pieces per hour, depending on the cooking time.

One use for a system of equipment like the NEFF system is in a "cook-and-serve" operation like a cafeteria. In such an operation, the conveyor belt which runs past the unloading end of each piece of equipment becomes the tray assembly line with each worker along the line portioning one type of food onto the tray. At an installation in Ludwigsburg, Germany, eight workers are able to serve fifty trays a minute. They can serve sixty to seventy trays a minute when they work at full capacity.

An adaptation of this procedure prepares individual trays for short-term storage prior to serving. The items to be heated are stored in one compartment of a specially-designed transport module while the items to remain chilled are stored in the other compartment. Both compartments are refrigerated while the module is in transit and at the destination until 45 minutes prior to serving. At this time, the heating elements in the module are activated, and the food in one compartment is heated to between 160 and 170 F. The various items for an individual meal are removed from the two compartments, placed on a single tray, and served. The modules are manufactured in two sizes; one will hold 20 complete meals and the other, 40.

The other type of food production system is designed for "cook-and-freeze" operations. It either freezes individual meals or freezes food in bulk. If individual meals are to be prepared, trays are assembled as in the "cook-and-serve" operation, covered, quick frozen, then placed in freezer storage. When food is to be stored in bulk, the product is unloaded from the cooking equipment directly into a "co-fill" unit. This device automatically weighs pre-set amounts of food into steam table pans and places them on a conveyor belt which carries pans to the packaging and freezing area.

The NEFF "cooking street" equipment is designed for efficient, high-volume production, but it features simplicity and reliability. If the work is distributed properly, two people can tend the five pieces of cooking equipment. The food operation at Ludwigsburg can serve 2,800 customers at noon with a total department staff of 22. Another installation in Karlsruhe can serve 5,000 people with a kitchen staff of 19. Another plant is capable of producing 46,000 TV dinners per day with only 74 employees.

The operation of all pieces of equipment is simple, with a minimum of sophisticated and complicated mechanisms. The cooking containers of the steamer, water cooker, and deep fat fryer, the transport bars and "flipper" of the grill, and the rod conveyors and infrared heating elements of the broiler are all removable without tools. The facility at Ludwigsburg has been operating for 16 years with only one maintenance call--to start up the equipment on the first day of operation.

Future Trends

A projection of future trends in food processing and preparation equipment follows in this section. We obtained our projection by looking at the past, at the equipment now being introduced, and at equipment now in the experimental stages. Heat transfer is a fundamental phenomenon involved in all equipment; thus the impact of new developments in this area were given priority. The last portion of this section indicates topics requiring future research to optimize these processes.

General Trends

These trends are evident throughout the food service industry. They do not apply only to certain pieces of equipment or specific types of operations. A close study of these trends may be the key to predicting what types of equipment will gain currency in the future.

Mobility. Much of the new equipment being introduced is available either as stationary units or mounted on wheels or movable bases. This second feature allows it to be used in the most convenient or efficient location for the task being performed. Production lines can be rearranged to suit the material being handled and different types of processing required. Mobile equipment also facilitates cleaning and repair as well as major modifications of the facility.

Flexibility. New equipment is being designed to provide the food service operator with greater flexibility in the use of his equipment.

Generally, this means units that can serve more than one function. Examples of this include combination ovens employing two types of heating, holding cabinets containing heated and refrigerated compartments in the same unit, large refrigerator-freezers that operate at either 40 F or 0 F at the flip of a switch, and fat fryers and steam cookers that can operate with or without pressurization.

Capacity. Both batch-type and continuous-type equipment are being made available with larger output rates. A good example is the new design of ovens and refrigerators which allows a rack of food trays to be wheeled into the equipment for processing. The European procedure of ganging ovens permits a number of racks of food to be stored, handled, and processed as a single group. Also as a result of mass production, alternative means of transporting the food product within the facility have been developed. Racks, carts, conveyors, and rollers move large-bulk packages which are often too unwieldy to be handled by human means alone.

Even with the emphasis on high-volume operations, though, smaller capacity equipment is not being phased out. These units find use in smaller facilities which cannot efficiently utilize large-capacity equipment. In operations where the work load may be highly variable, one or more of the smaller units, instead of larger ones, help prevent wasted space and food.

Process Control. Better control of the various cooking processes is now possible due to improved sensing and control of time and temperature. More accurate thermostats, thermometers, and timers on fryers and ovens, for example, allow closer monitoring of the cooking process. Automatic termination of the cooking cycle in, for example, fryers with timed basket lifts and steamers that exhaust the steam at the end of the cooking period, prevent over-cooking by human error.

Automation. The increasing use of automated equipment represents an attempt to offset the increasing costs of skilled and semi-skilled labor. Once the optimum time-temperature relationship for a particular product has been determined, the equipment can be programed by a chef or supervisor. Then only unskilled labor is required to feed the product in, monitor the operation of the equipment, and remove the product when it is finished.

The higher number of electrical and mechanical components required by automated equipment can, however, substantially reduce reliability. Methods of overcoming this problem include redundant circuits to provide back-up capability or, possibly, plug-in replacement modules similar to those used in today's electronic equipment.

Energy conservation. Since the recent energy shortage, energy conservation has become a matter of concern in all industries. Designers of food service equipment are devoting more work to improving heat transfer, reducing warm-up time, and avoiding wasted capacity in their units. Recently introduced systems show the results of this work somewhat, and those to be introduced in the future will undoubtedly be even more efficient.

Much controversy exists as to which energy source is appropriate for which equipment. Operators prefer gas-fired equipment, and gas is more efficient overall than electricity (49). But gas is in various degrees of short supply throughout the country and is more easily shut off to operators than electricity.

Computers. Data processing machines have been used for years to accomplish such standard procedures as payroll and inventory accounting. Today, though, they are being considered for much wider use in the food service industry. Computers can be used to control various cooking processes in response to programed instructions. This helps eliminate human error in processing, and it reduces the skill level required for adequate results.

An early application of computers was in an almost completely automatic drive-in restaurant (30). The customer enters his order by pressing buttons corresponding to menu items on a console; then a "go" button indicates that the order is complete. The computer activates the proper piece of cooking equipment: hamburger cooker, hotdog cooker, potato dryer, fryer for entrees like chicken, beverage dispenser, or milk shake dispenser. The cooked food and computer-produced totaled check are delivered to the assembly man. He matches the checks with the food items and places them on trays, adding such items as pickles and cole slaw. The computer totals all sales at each station and calculates the number of sales, both in units and dollar value, of all menu items.

Another possible computer application could be as a behind-the-scenes manager of a patron's meal in a standard table-service restaurant. When a customer calls for a reservation, the computer, or a person working in conjunction with the computer, would receive the customer's name, the size of his party, and the time at which they wish to eat. It would scan its memory banks to determine whether a table of suitable size is available at that time, verify the customer's credit rating, ask what he would like for a main course, inquire about the nature of the occasion, and even making dining suggestions. When the customer arrives, the computor would have assigned a table, printed a personalized welcome card, and informed the waiter of any special event to be celebrated. It would print out detailed descriptions of the main dishes ordered and suggest side dishes and appropriate beverages, all based on total food costs, the probability of selling a particular item, the occasion, and what the customer ordered the last time he ate at one of the restaurants sharing the computer.

The waiter would make appropriate notations on the order form and return it to the machine. The computer would then signal the kitchen equipment to extract certain food components from storage and activate the cooking equipment to heat each component to the proper temperature. Instructions would be printed out for the assembly man who would group the components into the classic, familiar dishes. The waiter would deliver the food to the table, giving the computer-produced explanation of each dish, its derivation, components, and the like.

The customer's bill would be printed item by item, allowing him to verify it before signing the check. The computer would retain in its memory what the customer ordered, how much he spent, and the date of any special occasions so that he could be invited in advance of the next occasion to return.

The computer could also maintain an up-to-date account of inventory and food costs, could reorder them when stocks get low, and could print out such information on each waiter as his record in selling wine, how often his customers return, and how much they spend (30).

Technological Breakthroughs

Every now and then, a breakthrough in the field of engineering, management, or food technology effects the food service industry, allowing it to move rapidly into a era of new concepts and procedures. In the field of engineering, the latest technological advance to have a profound effect on the foodservice industry was the development of the microwave oven. Introduction of the more efficient high-power microwave power module may bring about significant changes by making microwave processing practical on a large scale that it has been. But these changes will not be as radical as those caused by the original introduction of microwave processing.

A review of research in heat transfer presently being conducted reveals no imminent technological breakthroughs on the order of magnitude of the development of microwave processing. However, research on the heat pipe discussed earlier may reveal applications which will affect the future design of food service equipment. Because of the pipe's ability to pass large quantities of heat quickly and maintain a surface at a constant temperature, certain types of food service equipment may be capable of more efficient energy conversion by incorporating heat pipes into their design.

One piece of equipment to which heat pipe technology has already been applied is griddles. The purpose of the research was to determine if a heat pipe griddle could be constructed to provide a uniform temperature over the cooking surface, a short warm-up time, and accurate temperature control. The process also had to be relatively inexpensive, reduce gas consumption, and be capable of operating on commercial burners with only minor modifications. A summary of the performance of two griddles as described by Basiulis (3) appears below.

	Range "A"	Range "B"
Overall size	36" X 26"	36 1/2" X 32 3/4"
Cooking surface size	35" X 22"	35" X 28"
Griddle thickness	1 inch	1 inch
Rated burner capacity	66,000 BTU/hr.	140,000 BTU/hr.
Warm-up, room to 400 F	10 min.	5 min.
Warm-up, pilots to 400 F.	6 min.	3.5 min.
Cook 1/4 lb. frozen hamburger patties	5 min.	4 min.
Temperature distribution at 400 F	±5 F	±5 F

Heat pipes may be used to best advantage in equipment where large quantities of heat must be transferred and where warm-up time is now considerable. Besides griddles, pieces of equipment which seem to be logical candidates for heat pipe application are fat fryers and, possibly, convection ovens.

Future Research

We have stressed in this discussion the importance of heat and mass transfer in the design and fabrication of food processing and preparation equipment. We have also indicated that extaordinary research activites in the past 20 years in heat transfer have resulted in a significant increase in our knowledge of the basic fundamentals of heat transfer and our ability to design and predict heat transfer rates in equipment. One may well ask why has only a limited amount of this knowledge been applied in the food processing and preparation industry. The NEFF "Cooking Street" concept, which is only now being introduced into the United States, was conceived and developed in Germany over sixteen years ago.

The basic answer to these questions is one of communications. There is for all practical purposes only a very limited line of communications. There is the food service operator, the dietitian, the food technologist, the nutritionist, and the engineer with a knowledge of heat and mass transfer. This lack of communication has meant that the problems possessed by one group have not been sufficiently well defined in the vocabulary of another group to encourage or even allow assistance in obtaining solutions. Indeed one sometimes wonders if the groups are even aware that they have serious equipment deficiencies. This communication problem must be resolved on all levels, at the universities and research laboratories, at the industrial design and fabrication level, and at the lowest operating level.

With an improvement in communication a detailed specification of an acceptable thermal environment for the preservation and preparation of food can be obtained by the food service operator, the nutritionist, and the food technologist. The heat transfer engineer can then design a system that will optimize the process from the standpoint of cost, time, energy consumption, or labor involvement. Automatic or programable ovens will appear that respond to a data card attached to the packaged food product. It will be removed at time of preparation and inserted into the oven's controller, and the product will be processed in the optimum way for flavor and nutrition retention.

But significant advance in these areas will be possible only if

1) Improvements in technical communication between the engineering community on the one hand, and the food service operators, the food technologist, and the nutritionists, on the other, are obtained; and
2) An extension program is developed to define clearly the optimum thermal environment needed for the processing and preparation of food products.

APPENDIX

Basic Principles of Heat Transfer

There are three basic modes of heat transfer: conduction, convection, and radiation. The latter two modes often occur simultaneously, thus the total heat transfer from a surface can be the sum of the convective and radiant heat transfer.

Heat Conduction

Conduction is the process by which heat flows from a region of higher temperature to a region of lower temperature within a gas, solid, or liquid by direct molecular interaction and without appreciable displacement of the molecules. The energy possessed by matter is proportional to the sum of its molecular kinetic energy and the relative position of the molecules. It is called the "internal energy." The internal energy is directly proportional to the temperature of the matter. When higher internal energy molecules (high temperature) come in contact with lower internal energy molecules, part of their energy is transmitted by either the elastic impact of the molecules or the diffusion of faster moving electrons, and heat is said to be "transferred by conduction."

The rate at which heat is conducted is given by Fourier's Law (1822). It is important to note that the heat flux is a vector and thus has direction as well as magnitude. The flux is proportional to the thermal conductivity, K, the area of the section perpendicular to the flow of heat, A, and the rate of change in the temperature, T, with respect to the distance measure in the direction of heat flow. For one-dimensional heat flow the expression is

$$q_{\chi} = -KA \frac{\Delta T}{\Delta \chi} \quad \text{(Fourier's Law)}$$

where the heat flows in the direction of the positive x axis. An increase in either the thermal conductivity or the temperature gradient, $\Delta T/\Delta \chi$, will result in an increase in the rate of heat transfer. An order of magnitude grouping of the thermal conductivities of some common materials is given in Table 1. For the one dimensional flow of heat, the concept of thermal resistance to the flow of heat is often introduced and is defined as

$$R_K = \frac{\Delta \chi}{KA.}$$

Table 1

Thermal Conductivity of Different Materials

Material	K, Btu/hr-ft-F
Gases at atmospheric pressure	.0004-.10
Insulating materials	.02-.12
Nonmetallic liquids	.05-.40
Food products	.0074-.78
Nonmetallic solids	.02-1.5
Alloys	8-70
Pure metals	30-240

In many instances the boundaries of the surface are not perpendicular and one encounters two- or three-dimensional heat transfer. The condition in each direction is given by Fourier's Law, and a limiting process is used to arrive at an energy balance describing the transfer of heat. The energy equation, which is a partial differential equation, must be solved for each particular problem using the appropriate boundary conditions.

In many applications the rate at which heat is transferred is not steady but is time dependent. The temperature distribution in the material is thus dependent not only on the above noted items but on the rate at which enery is stored. The energy storage is dependent on the density, ρ, and specific heat, C, of the material. It is usual to utilize the thermal diffusivity, $\alpha = \frac{K}{\rho C}$, in the analysis of transient conduction problems. Representative values of thermal diffusivities for different materials are presented in Table 2.

Table 2

Thermal Diffusivities of Different Materials

Material	α - ft^2/hr
Gases	.6 - 10
Insulating material	.01
Nonmetallic liquids	.002 - .005
Food products	.0044 - .0068
Nonmetallic solids	.006 - .02
Alloys	.15 - 1.2
Pure metals	1.6 - 4.4

The most simple transient analysis is denoted as the lumped parameter analysis and assumes that there is negligible internal temperature variation in the solid. The rate at which heat is stored or removed from the solid is related to the ease with which heat is transferred from the body to the surrounding fluid. Assume that the fluid is at a temperature T_∞ and the body is initially at a temperature of T_0. The temperature distribution at any time θ is given by

$$\frac{T-T_\infty}{T_0-T_\infty} = e^{-\frac{hA}{\rho CV}\theta}$$

where A is the surface area, V is the volume of the material, ρ is the density, C is the specific heat and h is the convective film coefficient (to be discussed in more detail in the convection section). The rate at which heat is removed or added to the solid is given as

$$q = C\rho V(T_\infty-T_0)\ [1-e^{\frac{-hA}{C\rho V}\theta}]$$

and indicates that a large surface area to volume configuration ratio is desired for highest heat transfer. The lumped parameter analysis is valid for many of the conditions encountered in food processing and preparation with an error of less than 5 percent introduced when $hV/AK_s < .1$ where K_s is the thermal conductivity of the solid.

When temperature gradients can not be neglected in the solid, the conduction heat transfer analysis becomes more complex; an interested reader should consult a basic heat transfer book like Kreith (26) or a more specialized book like Schneider (45). A useful relationship to remember is that, for a large number of cases, the rate of heat transfer is inversely proportional to the square root of the thermal diffusivity and time, while the total heat transfer is proportional to $K_s \sqrt{\theta/\alpha}$.

Heat Radiation

In a very broad sense radiation is associated with all kinds of electromagnetic wave phenomena, thermal, light, and so forth. They usually differ only in their respective wave lengths. In heat transfer, the radiation is associated with the temperature of a body, and it can be transported through a transparent medium or through a vacuum. All bodies thus emit thermal radiation with the level determined by the temperature of the body and the characteristics of the radiating surface. The rate of heat transfer is determined not only by the radiating body but also by the radiation characteristics of the receiving body and the geometrical relationship between the bodies since radiation travels in a straight line path. Incident thermal radiation on a surface will be either absorbed, reflected, or transmitted through the solid. The general expression for the transfer of heat by radiation is

$$q_r = \sigma A_\varepsilon F_{1-2} \left(T_1^4 - T_2^4\right)$$

where σ is the Stefan-Boltzman constant ($.1714 \times 10^{-8}$ Btu/hr $ft^2 R^4$), A is the surface area (ft^2), F_{1-2} is geometrical shape factor, F_ε is a factor which takes into account the radiation properties of the surface. The temperatures are given in R (460 + F). This relationship indicates the dominating dependence of the radiation heat transfer on the temperatures of the radiating bodies. If a body is at 100 F and the surrounding either at 200 F or 500 F, the higher temperature will transfer 390 percent more heat to the enclosed body.

Heat Convection

Convection heat transfer is the method by which heat is transferred between a solid and a liquid or gas. The complete process is quite complex but generally takes the following form: Heat flows from the interior of a solid to its surface by the process of conduction, as previously described. Heat is then conducted from the surface to the particles of the fluid adjacent to the surface, thereby increasing the internal energy and temperature of the particles. The warm particles move away from the wall into the cooler fluid, mix with the fluid and transfer part of their energy. If the fluid movement takes place because of density differences created by the temperature gradients (buoyancy effects) the heat transfer process is referred to as "natural" or "free convection." When the movement of fluid is the direct result of an external source such as a pump or fan, the process is denoted as "forced convection." The rate of heat transfer may be calculated using the following relationship

$$q_c = hA\Delta T$$

where A is the surface area, ΔT is the temperature difference between the surface and fluid and h is the convective heat transfer coefficient. The magnitude of h is dependent upon the type of convection (natural or forced), the type of flow (laminar or turbulent) and the fluid. Representative values of film coefficients are given in Table 3.

Table 3

Convective Heat Transfer Coefficient

Condition	h Btu/ft^{2}hr F
Steam condensing	1000 - 20,000
Water, boiling	500 - 10,000
Water, forced convection	50 - 2,000
Oil, forced convection	10 - 300
Air, superheated steam forced convection	5 - 50
Air, natural convection	1 - 5

To illustrate the significance of these results on food preparation, it can be seen that if the temperature difference is held constant, a tenfold increase in the rate of heat transfer will result if one switches from a natural convection to a forced convection unit.

Glossary

Change of phase. In this study, three physical phases concern us: solid, liquid, and gas. When certain conditions--temperature or pressure, for example--to which a substance is exposed change, the substance may itself change from one phase to another. For example, water undergoes a change of phase to ice or to and from steam with certain temperature changes.

Conduction. Conduction is a method by which heat diffuses within a body, or from one body to another, or from a region of high temperature to a region of low temperature, with no gross molecular movement.

Convection. Convection is a means of heat transfer wherein heat is transported from one point to another by the movement of hot material between those two points. The medium that transfers the heat is a fluid, either liquid or gaseous.

Convective film coefficient. In convective heat transfer, there is always a stagnant layer of fluid next to the solid substance. The convective film coefficient is a measure of how well heat can be transferred through this stagnant film of fluid. The units are typically expressed in (calories)/(seconds) (cm^2) (degrees C).

Dielectric properties. Dielectric properties are those properties that describe the molecular reaction of a substance to an electric field. Certain of these properties determine to what extent a substance will absorb microwaves and thus undergo a rise in temperature.

Electromagnetic waves. Wave phenomena characterized by variations of electric and magnetic fields are electromagnetic waves. Radio waves, heat, light, x-rays, microwaves, and many others are electromagnetic waves differing only in frequency.

Fluid mechanics. Fluid mechanics is the study of the mechanical properties of fluids and the laws and forces governing their behavior under both static and dynamic conditions.

Heat and mass transfer. This term denotes the movement of heat or mass from one body or substance to another, or within the body or substance itself. In food service applications, we are concerned with the transfer of heat from a body during freezing or refrigeration and to a body during cooking. Mass transfer considerations in this application are generally limited to the moisture loss that occurs during cooking operations.

Internal energy. Internal energy is the energy contained within a substance due to its state, not to its bulk movement or position. In our discussion, the internal energy of a substance is a measure of its temperature and specific heat.

Lumped parameter analysis. The study of a system in which the properties (temperature, pressure, density) of each substance are considered to be constant throughout the body is known as a "lumped parameter analysis." Although gradients and variations exist, an analysis of this type can provide a good approximation of the reaction of the system.

Radiation. Radiation is the transfer of energy from one point to another by means of electromagnetic waves. Radiation striking a body is converted to heat due to the molecular absortion of the radiant wave energy.

Specific heat. Specific heat is a measure of the amount of heat required to raise a mass of a substance over a certain temperature increase. Common units are (calories)/(degrees C) (grams). The higher the specific heat, the more heat is required to raise the temperature of a given mass. Likewise, more heat is released by a given mass when it undergoes a drop in temperature.

Standing waves. Due to the regular rectangular shape of an oven cavity, each successive wave of microwave power will follow the same path as the previous wave. It will reflect from metallic surfaces throughout the oven until absorbed by the product. Where no waves pass through the product, heating will take place only by conduction of the heat from higher temperature areas of the oven. If two wave paths cross within the product, excessive heating occurs. For this reason, a diffuser or "stirrer" is required to disperse the microwaves in different directions when they are directed into the oven cavity.

Stefan-Boltzman constant. This proportionality constant relates radiation from a body to the fourth power of the temperature of the body. Its numerical value has been determined experimentally.

Thermal conductivity. Thermal conductivity is a measure of how well a substance conducts heat. Units are typically represented as (calories)/ (cm^2) (degrees C). Materials with high thermal conductivities, like metals, conduct heat readily; those with low thermal conductivities act as insulators.

Thermal diffusivity. The quantity K /C_v where K is the thermal conductivity of the substance, is the density, and C_v is the specific heat is the thermal diffusivity of of a substance. The magnitude of this quantity is a measure of how quickly a body with a mon-uniform temperature will approach equilibrium.

Thermocouple. A thermocouple is a device consisting of two wires of different metals welded or soldered together. As the temperature of the junction is increased, a larger voltage difference is produced between the wires. This voltage can be measured and the temperature at the juncture calculated.

Thermodynamic properties. The thermodynamic properties of a substance are those properties that determine its behavior when heat is transferred into or out of a body of that substance.

Thermister. A thermister is a device made of semi-conductor material that exhibits a change in resistance when subjected to a change in temperature. The resisitance can be measured and the temperature calculated.

Turbulent flow. Turbulent flow is the combination of a uniform fluid flow and irregular eddy currents.

Food Processing and Preparation Equipment:

A Bibliography

1. Anon. "An Age of Ecology and Consumerism," Fast Food, 71-10 (May, 1973), p. 116.

2. A.P.V. Company, Inc., Brochure on APV-Torry Vacuum Thawing Plant.

3. A. Basiulis. "Stainless Steel Griddle Utilizing Heat Pipe Vapor Chamber Design," ASME publication No. 73-WA/HT-16.

4. Broaster Company, Brochure on model 70 "Aristo-Ray" broiler.

5. Connerton Appliance Company, Brochure on Connerton "Multiplex" broilers.

6. Crescent Metal Products, Inc., Cres-Cor 666 consumer catalog of food service equipment, 1972.

7. Crown-X, Inc., Convection oven catalog no. 670.

8. J. J. Daly, Jr. "The Freon Freezant System," Food Processing Industry, 42-495 (January, 1973), p. 27.

9. Robert V. Decareau. "Electrically Powered Field Kitchens," Cornell Hotel and Restaurant Administration Quarterly, 12-1 (May, 1971), p. 73.

10. E. F. Johnson Company, Inc., Brochures on NEFF model numbers 81A, 82A, 84A, 85A, 87A, 88A and Dynamic Systems Inc. model CTM-40.

11. Anon. "Exploding the Myth of the Kitchenless Kitchen," Institutions/Volume Feeding Management (December 1, 1970), p. 50.

12. Richard Flambert. "Today's Design for Tomorrow's Food Facility," Cornell Hotel and Restaurant Administration Quarterly, 6-1 (May, 1965), p. 54.

13. Foster Refrigerator Corporation, "Tomorrow" line refrigerator and freezer catalog no. 4A.

14. Fostoria Industries, Inc., Infrared broiler bulletin no. 50-521-73.

15. Morton Fox and Avalon L. Dungan. "SPEED Field Feeding System," *Cornell Hotel and Restaurant Administration Quarterly*, 9-1 (May, 1968), p. 57.

16. Frank N. Giampietro. "Is Your Kitchen Obsolete?" *Fast Food*, 71-10 (October, 1972), p. 110.

17. Frank N. Giampietro. "Is Your Kitchen Obsolete?" *Fast Food*, 71-11, (November, 1972), p. 138.

18. Frank N. Giampietro. "Is Your Kitchen Obsolete?" *Fast Food*, 71-12 (December, 1972), p. 50.

19. Frank N. Giampeitro. "Is Your Kitchen Obsolete?" *Fast Food*, 72-1 (January, 1973), p. 30.

20. Hobart Manufacturing Company. Brochure on M-V and M-S series refrigerators.

21. Hughes Aircraft Company, Electron Dynamics Division, "Heat Pipe Technology for Industry."

22. Morris R. Jepperson. "Techniques of Continuous Microwave Food Processing," *Cornell Hotel and Restaurant Administration Quarterly*, 5-1 (May, 1964), p. 60.

23. M. A. Jiménez. "Microwave-Convection Heating of Foods in Aluminum Containers," *Food Technology*, 26-9 (September, 1972), p. 36.

24. Richard T. Keating. "Equipment--Where Do We Go From Here?" *Cornell Hotel and Restaurant Administration Quarterly*, 6-1 (May, 1965), p. 65.

25. Roger T. Keefe and Samuel A. Goldbiith. "Hospital Feeding via Microwave Kitchenettes," *Food Technology*, 27-8 (August, 1973), p. 16.

26. F. Kreith. *Principles of Heat Transfer*, 3rd edition (New York: Intext Educational Publishers, 1973).

27. C. K. Litman. "A Refrigeration for Convenience Foods," *Cornell Hotel and Restaurant Administration Quarterly*, 12-1 (May, 1971), p. 64.

28. G. E. Livingston and Charlotte M. Chang. "Second Generation Reconstitution Systems," *Cornell Hotel and Restaurant Administration Quarterly*, 13-1 (May, 1972), p. 57.

29. K. Lorenz; E. Charman and W. Dilsaver. "Baking with Microwave Energy," *Food Technology*, 27-12 (December, 1973), p. 28.

30. James T. Mathews. "Planning Today for Tomorrow's Food Facilities," *Cornell Hotel and Restaurant Administration Quarterly*, 6-1 (May, 1965), p. 46.

31. Anon. "Minute Man of America Combats Pollution," *Fast Food*, 71-9 (September, 1972), p. 62.

32. Nuri N. Moshenin. *Physical Properties of Plant and Animal Materials, Thermal Properties, Vol. 2, Part 1*, (New York: Gordon and Breach, in preparation).

33. Anon. "Preparing Ready Foods," *Cornell Hotel and Restaurant Administration Quarterly*, 6-2 (August, 1965), p. 21(8).

34. Anon. "What is Pressure Frying?" *Institutions/Volume Feeding Management, Vol. II, Pressure Frying* (1973).

35. Anon. "The Pressure Fryer," *Cooking for Profit*, 42-271 (July, 1973), p. 44.

36. Clyde L. Rasmussen and Robert L. Olson. "Freezing Methods as Related to Cost and Quality," *Food Technology*, 26-12 (December 1972), p. 32.

37. Raytheon Company, Industrial Microwave Processing, Brochure on model no. QMP1679 Tempering Tunnel.

38. Betty Ronan. "A 'Cooking Street'--Is It A Possible Food Preparation System?" *Journal of the American Dietetic Association*, 63-4 (October, 1973), p. 417.

39. Carl-Gustav Rosén. "Effects of Microwaves on Food and Related Materials," *Food Technology*, 26-7 (July, 1972), p. 36.

40. Joseph P. Ryan. "Nitrogen Freezing--A Progress Report," *Cornell Hotel and Restaurant Administration Quarterly*, 9-1 (May, 1968), p. 20.

41. R. H. Sabersky. "Heat Transfer in the Seventies," *International Journal of Heat and Mass Transfer*, 14 (1970), p. 1927.

42. Helen Sanstadt. "Around the Menu with Convection Ovens," *Cooking for Profit*, 41-260 (August, 1972), p. 18.

43. Helen Sanstadt. "Around the Menu with Gas Broilers," *Cooking for Profit*, 41-262 (October, 1972), p. 51.

44. Helen Sanstadt. "Around the Menu with Steam Cooking," *Cooking for Profit*, 41-256 (April, 1972), p. 40.

45. P. J. Schneider. *Temperature Response Charts* (New York: John Wiley and Sons, Inc., 1963).

46. Bernard Schukraft. "Integral Heat System for Volume Food Preparation," *Food Technology*, 26-9 (September, 1972), p. 27.

47. Traulsen and Company, Inc., Brochure on "Even Thaw" refrigerators.

48. Michael Whiteman. "Where Do We Go From Here?" *Cornell Hotel and Restaurant Administration Quarterly*, 12-1 (May, 1971), p. 24.

49. Gene Yetter. "Energy 'Brownout' Hit the Food Service Business," *Fast Food*, 71-10 (May, 1973), p. 130.

50. Anonymous. "Innovative Equipment." *Institutions/Volume Feeding* (September 1, 1973), p. 56.

51. Mark E. McCormack. "Distillate Fuel-Fired Kitchens." *Cornell Hotel and Restaurant Administration Quarterly*, 12-1 (May, 1971), p. 79.

52. Anonymous. "Disposables." *Institutions/Volume Feeding* (March, 1970), p. 105.

III

FOOD PROCESSING METHODS: THE STATE OF THE ART AND ITS FUTURE EFFECT ON FOOD SERVICE

by

Joseph H. Mac Neil, Ph.D.

and

Barbara Bollinger

FOOD PROCESSING METHODS: THE STATE OF THE ART AND ITS FUTURE EFFECT ON FOOD SERVICE

Introduction

Food science obviously contributes a great deal of information to the food service discipline and industry, and the role of food science and its relationship to the food service industry is the focus of this report. More specifically, our approach has been to provide a thorough discussion of some of the more important food processes that will almost certainly affect the food or the food preparation systems required by the food service industries of the future. For example, how the food reaches the food service establishment will certainly have some bearing on the type of preparation that goes on at the serving site. These preparation procedures have traditionally ranged, and will continue to range, from simple heat-and-serve to taking the raw food and preparing it from scratch. The procedures will change little; their use ratios will change substantially.

In the past, there has been altogether too little communication between the food scientists and technologists on the one hand, and the food service practitioners on the other. While both groups endeavor to improve food quality and lower its cost, they have tended to operate exclusive of each other. This Project has demonstrated that a unified approach to the problems of both interest groups certainly would work to their mutual advantage. There exist great areas of overlapping interest--which this Project has served to point out repeatedly over the preceding six months.

We refer to the subject matter covered in this report loosely as "food science," but it might be more accurate to call it "the food processing areas of food science." Even with this more restrictive partitioning, however, we are left with an extremely complicated, multi-faceted area. We attempt to provide our reader with a knowledge of the various processes being used in the industry today and how these processes might be used to produce the product ultimately used by the food service industry. It is not a comprehensive view of all the processes, rather it tries to convey the nature of each process and the extent to which it is presently being used by the food processing industry.

The technological information for producing new food products, along with the complementary, sophisticated procedures, is available now. To what extent this knowledge will be used in the food service industry in the next few years will depend on the type of individuals charged with the decision-making responsibilities and the training they receive. Will the food service industry concentrate solely on business or will it become more involved, with the food scientists, in the ramifications of the rapidly changing food processing techniques? We cannot answer this question, but in this report, we have attempted to isolate and discuss the considerations that will shape an answer soon.

Food Dehydration: The Most Widely Used Method of Food Preservation

Although the major products being dehydrated in the United States today are essentially the same as they were in 1960 (sugar, starch products, coffee, milk products--especially non-fat milk and whey--and flour mixes, with good markets for breakfast and pet foods, pasta products, and dried fruits and vegetables as well), since that time there have been other changes. The production of dried breakfast foods, mixes, and potato and corn chips has increased, for example, and much of the production of processed coffee has been taken over by freeze-drying. Also other countries now surpass the U.S. in drying fruits and vegetables. The methods of dehydration, however, have remained basically unchanged. In 1963, 55 percent of all dried products were air-dried, 40 percent were spray-dried, and less than 5 percent were dried by other methods. It is probably still true that these two methods account for most industrial dehydration. (Karel, 44)

Air Drying

Air drying is the dehydration of solids in air, which is accomplished by exposing foods to heated air in direct dryers. Sometimes these dryers are used with indirect dryers, which heat the surfaces on which the food is placed. Primarily convection provides the heat transfer, but additional heat may be supplied by radiation or conduction, using batch dryers (tray dryers, kiln dryers, and some types of fluid beds) or continuous dryers (tunnels, rotary dryers, and belt or band dryers. (Karel, 44) Often the manufacturer adopts the tunnel dryer, which is by far one of the most flexible systems in commercial use. In its simplest form the tunnel dryer is a rectangular structure (whose dimensions vary greatly, dependong on the capacity of the plant), which will accommodate trucks containing tays, spread uniformly with the product to be dried. The tunnel is essentially continuous and the trucks gradually enter one by one and are removed when equilibrium of the product is established. Tunnel systems are classified according to how the air traverses the product, the single-stage parallel air flow being one of the simplest systems. In this one, the "wet" material first encounters the driest, warmest air, then leaves the dryer at the cooler end of the tunnel. Although the highest rates of evaporation are achieved initially, there is little danger of overheating the product since the surface temperature of the food is below the dry bulb temperature due to heat loss through evaporation. The product is protected in the latter stages of drying because the air is getting progressively cooler. This cooler air also causes a decreased drying rate in the latter stages. The ultimate disadvantage, however, is that a product of very low moisture cannot be produced no matter how long the tunnel is. Commercial plants use this system mainly for drying grapes; however, it is usually used in combination with a counterflow system.

In the single-stage countercurrent flow dryer, air is directed against the movement of the product. The dry product leaving the dryer encounters the hot and dry air entering the system. The "wet" product, then, is initially exposed to very slow drying conditions. However, provided precautions are taken not to overheat the product, it ultimately has a lower moisture content than it would have if processed by the previously mentioned system. The counter flow system is more economical to operate than the parallel flow and is widely used for commercial production, mainly for processing dried vegetables. The greatest problem with the system is product shrinkage. The dried product has a relatively high density and slow reconstitution properties, whereas the parallel flow system produces a dried product with much less shrinkage and a lower density.

Double-stage dryers are available with both countercurrent/parallel flow and parallel/countercurrent flow. The bulk of the commercial two-stage plants in this country are the latter type, probably because of its more uniform drying and its high output of good quality products. The system produces high initial evaporation and, often in practice, the first stage is shorter than the second to compensate for the latter's low rate of drying. However, equal length tunnels are widely used, and it is possible to place them side-by-side for loading and unloading at the same end. In many systems, air from the secondary tunnel is used to supply the parallel flow system. The advantage of this is that it allows the temperature of the air in either system to be adjusted as desired.

The chief advantage of the three-stage dryers is that they are more flexible and can achieve nearly optimum conditions for drying a wide range of products. However, the few of these in operation use three tunnels with countercurrent air flow. An important implication of these dryers for the future is their total recirculation system which solves the odor problem associated with onion and garlic dehydrators. The method involves interstage heat transfer with dehumidification.

Another type of dryer is the bin-type finish dryer which serves as a place for equilibrating temperatures, obtaining final moisture levels, and storing dried products prior to packaging. Basically, these dryers are cylinders through which blows warm air at a velocity not greater than $100ft^3$ per minute per $ft.^2$ This dryer provides a low-cost method of removing moisture from particular products during the slowest stages of drying. Both the statis and portable units require 24 to 36 hours to reduce the moisture content of vegetables from 10 percent to 5 percent.

In the conveyor-type dryer, which resembles the tunnel dryer, material is conveyed through a hot air system on a continuous moving belt, with the result of reduced handling costs. The wet material is loaded uniformly about 6 to 8 inchdes deep onto a belt made of either woven metal mesh or interlocking perforated plates and is dried initially by air blowing through the bed and finally by air passing down through the bed. The latter prevents material from being lost from the system due to changes in density during drying. Belts vary from 30 to 60 feet long and from 6 to 100 feet wide. By sectionalizing the system, it is possible to control independent flow rates, temperatures, and humidities (which is essential for high capacity water removal) and thereby receive optimum output and quality. Also, it is necessary to remove the material at a moisture level of approximately 15 percent to avoid excessively long belts and the waste of evaporating capacity. (Holdsworth, 43)

Modern industry in general has increased instrumental analysis feedback control, and automatic operation of process lines, but these developments have lagged in food processing for at least three reasons: (1) food materials are complex and difficult to describe in simple engineering properties; (2) the measurement of on-line and feedback control with regard to food processing is difficult; and (3) it is hard to find food technologists with adequate background and experience in engineering. Some progress, however, has been made. Extensive on-line moisture measurements are now available and one control scheme for a fluid bed dryer is based on three temperature measurements: inlet air temperature, outlet air temperature, and the temperature of the air wet bulb. Control is maintained by monitoring the temperature of the inlet air to compensate for the changes in the other temperatures. (Karel, 44)

The major problem in air drying solid foods is that the drying rates must be limited as moisture control decreases because of the low diffusibility of the moisture. The associated problems of shrinkage and organoleptic changes lower the quality of the product. Air-dried solids also run the risks of (1) poor rehydration, (2) burning and flavor deterioration during drying, and (3) lipid oxidation, as well as oxidation of lipid-soluble pigments, vitamins, and some water soluble compounds both in drying and storage.

Researchers are continuing to look for ways to counteract the aggregation in solids during dehydration that limits both the drying and rehydration rates. (Karel, 44) The demand for better and faster reconstitution in dehydrated products led to the development of the "explosion puffing process" by the United States Department of Agriculture (USDA) at the Eastern Utilization Research and Development Division near Philadelphia. The process is now recognized as one of the most significant developments in dehydration technology, for its products have many of the desirable attributes of freeze-dried food, and they can be processed at a cost comparable to that of conventional air drying.

Explosion puffing reduces rehydrating and reconstituting to a few minutes. In the process, pieces partially dehydrated by a preliminary stage drying are heated in a closed rotating cylinder known as a "gun" until a predetermined internal pressure has been reached. The gun is then discharged instantly to atmospheric pressure. During the process a certain amount of water is vaporized, but more importantly, the explosive, or flashing, conditions result in a highly porous network of capillaries within the particles. This porosity enables the final dehydration to be achieved much more rapidly (in about one-half the time) than would be possible with conventional dried products. It also allows the product to reconstitute very rapidly.

At present, explosion puffing can produce dehydrated carrots, beets, white and sweet potatoes, celery, and fruit; it works especially well with apples and blueberries. (Holdsworth, 43)

Another possible way to combat aggregation of solids during dehydration is to freeze and thaw foods prior to drying in order to increase internal porosity and ease of mass transport. The idea itself is not new, but a new method of carrying it out has been patented.

In this method, food that has been previously pressurized with 500 to 1500 psig of methane, nitrogen, CO_2, air, freon, or ethane is frozen. The pressurized frozen substances are then air dried, and they retain their shapes. The developer does not fully understand the phenomenon himself, but he believes that bubbles of gas are retained within the solids during melting and drying, thus preventing shrinkage. (Karel, 44)

A third method of preventing shrinkage has also been proposed. This method involves irradiating dried vegetables with ionizing radiation to produce scission of some polysaccarides, with the result of improved rehydration and texture. However, the use of ionizing radiation is not currently allowed by the Food and Drug Administration. (Karel, 44)

One recently proposed process for dehydrating solids in air is the fluidized bed, which has been used in the food industry for freezing, mixing, transporting, heating, agglomerating, and drying. This system has the advantage of a simple design, initmate gas-to-particle contact, and uniform particle exposure to air without mechanical agitation. It is an extremely simple piece of equipment that can be made continuous if some back mixing can be tolerated.

However, conventional fluidized beds have several disadvantages which restrict their use in the food industry to the preparation of food powders. (Brockman, 20) Work on centrifugal fluidized beds (CFB) by the USDA led to the conclusion that drying food pieces in a CFB with relatively high air flows may be self-limiting, even when only partial drying is desired. The rate increases obtained in early drying-stages may be more than offset by the rate-retarding effects of a skin-like layer of collapsed surface tissue which forms on the food pieces. As the drying process continues, this tissue becomes increasingly resistant to heat and moisture. (Lazar and Farkas, 48) However, in 1972 the USDA modified the design of their CFB. The new design subjected the food particle to a centrifugal force greater than the gravitational force during fluidization, with the result that the CFB could accommodate different sizes of food pieces, as well as alter the amount of heat required in processing them. The new process increased the apparent density of the particle and allowed smooth, homogeneous fluidization, which could be achieved at any desired gas velocity by varying the centrifugal force. Also, increased gas velocity can provide improved heat transfer at moderate gas temperatures without the problem of scorching or surface heat damage associated with higher gas temperatures. The USDA successfully blanched, dried, and puffed potatoes, apples, and carrots with their modified CFB. They are now working on equipment for continuous processing and on techniques for ensuring uniform product flow down the length of the CFB cylinder. (Brockman, 20) Recently peas, beans, diced vegetables, potato granules, onion flakes, and fruit juices have been successfully dried on conventional fluidized beds. (Holdsworth, 43)

A novel idea for increasing the drying rate of foods processed by the CFB has been examined by Bartolome, et al. (7), who found that shorter drying time and lower drying temperatures were possible when forced air drying of potato cylinders was coupled with longitudinal standing waves of a maximum near 8,100 cps. Then researchers felt their method could have commercial application; however, they cautioned that to conserve power and to minimize noise, standing waves should be used and drying equipment should be designed specifically with this usages in mind.

Spray Drying

Nearly as important as air drying to the industry is spray drying, which is used to process a wide variety of products, including coffee, eggs, milk products, bananas, blood, cake mixes, casein and caseinates, cheese, citrus juices, corn hydrolyzates, fish concentrate, potatoes, protein from various plant sources, soy isolates and hydrolyzates, starch and starch derivatives, tea, tomato puree, yeast, cream, ice crea, and yogurt.

In the process of spray drying, a liquid or paste is sprayed into a chamber, where it contacts a steam of hot air and is dehydrated. The dry particles, suspended in the air stream, flow into the separation equipment where they are removed from the air, collected and packaged, or subjected to further treatment (such as instantizing). Each step constitutes a complicated and delicately-balanced engineering operation (Karel, 44)

Spray drying often eliminates the need for filtering or reducing the size of particles. Fourth, spray drying allows for coating the particle with another substance. Finally, a continuous spray drying system eliminates all manual handling of the product, thus producing lower labor costs, improved working conditions, better product recovery, and more consistent products.

Unfortunately, there are some problems. Spray drying is more expensive than most other air-drying techniques because the thermal efficiency is often lower than that of other types of dryers. Therefore, higher fuel and power costs must be set against the savings in manpower in a continuous system. However, cost becomes markedly less as the capacity of a plant increases. Second, although spray-drying is used for heat-sensitive materials, there is a greater potential for thermal damage with this method than with the still more expensive freeze-dehydration method. Third, a major problem still exists in the equipment. The atomizer determines the size of the droplets and is the most important feature of the spray dryer. But threads of liquid tend to be uneven, and when the distribution of particle size is uneven, the droplets interact and coalesce, which results in a lower-quality product. One reviewer notes that apparently there has been no drastic new developments in the last few years in rotating disc atomizers and pressure nozzles. Recently, sonic and ultrasonic droplet production have received attention, but they have not yet been applied by the food industry. (Karel, 44)

The main aim of spray drier design over the last 25 years has been to achieve high overall thermal efficiency with high throughput. Large plants with the capcity to spray-dry 6000 to 7000 gallons of liquid per hour are becoming common, with most major developments concentrating on milk products. Many of these plants use automatic air temperature control units, and other components of the plant, including filter replacement, are also becoming automatic. More drying chambers are being installed in the open, reducing building costs. But the recent concern over air pollution and the attendant legislation will undoubtedly require improved methods for separating powder from waste. Also recently, drying procedures have been modified for filled milk and other specialty items.

Spray-drying continues to be important for producing dried eggs and instant coffee (although agglomeration and freeze-drying now have the interest of coffee processors) as well as fruits and tomato products.* However, one problem is that products with a high content of sugar and other soluble solids tend to adhere to the walls of the drying chamber. Two solutions, modifying the process and adopting various additives, have been suggested, but at present both are too costly to be commercially feasible. Very recently, however, a dual dryer was developed which atomizes liquid products at the top of a spray-drying chamber, mixes them with heated air, and then directs them onto a screen mesh conveyor belt. The partially-dried particles form a mat and are then circulation-dried. The developer has found this method successful for processing calf starter, whey, and cheese. (Karel, 44)

In conclusion, the continuous spray-drying process produces a high-quality, economical product and is likely to continue to dominate liquid food processing since it is a well-established method that probably will not experience frequent, drastic changes and innovations. (Karel, 44) In fact, it will no doubt become more widespread as it finds applications among newly developed products from the foodstuff and polymer sectors.(Lyne, 53) For example, the spray-drying of fruit-milk protein combinations may be of substantial importance in the future because milkshakes, yogurt, and flavored dairy drinks are popular with consumers. (Karel, 44) Also, with the current attitudes or pollution, an increasing number of effluents will be concentrated and spray-dried to become a saleable product instead of being put down the drain. (Lyne, 53)

---

* The world's largest egg drying facility is in Riverside, California.

Recently, a great deal of research has centered on "instant" powders produced from various foods by spray-drying. (The term "instant" implies a rapid and complete rehydration in water or another liquid.) The industry has produced these instant powders through a combination of surfact treatments and agglomeration. The surface treatments include incorporating surface-active materials into the food to improve its ability to absorb moisture; coating spray-dried products with an additive that increases its ability to absorb moisture; and imbedding primary particles in a substrate which, although soluble in the rehydration liquid, keeps the particles separated during their initial contact with water. Also the porosity of individual particles increases when freeze drying or foam drying are substituted for spray drying. The other method, agglomeration, may be accomplished in two ways: either as part of the spray-drying process or, more commonly, as a later step. In this latter method, the spray-dried powder is carefully rewetted and the particles are brought into contact and allowed to grow into aggregates. The aggregates are then redried, cooled, and separated by size.

Several companies have developed processes for making instant milk powders. These processes vary primarily in the type of equipment they use for each of their steps. Most of the methods developed for milk can also be applied to other spray-dried particles, including sugar-containing mixtures.

The recent "agglomeration boom" in the coffee industry is a controversial subject. Some feel that there is no good technical reason for agglomerating spray-dried coffee and that the trend toward agglomeration is a sales gimmick promoted by companies trying to imitate the appearance of the excellent freeze-dried coffee in order to fool the public. Further, since agglomeration is only feasible for the large processor, some look on it as an attempt to force the small processor out of business. (Karel, 44)

Foam Drying

A great deal of research and development over the last 25 years has been directed toward adapting foam-drying techniques to liquid foodstuffs. Substantial work has been done on developing processes, equipment, and products; on understanding the basic process mechanism; and on measuring product quality and storage stability. Early findings are favorable, good processing definitions exist, and suitable equipment is available. But foam-drying technology, with the possible exception of gas-inflation spray drying, is not yet widely used. Hertzendorf and Moshy (41), finding no reason given for this in previous research, have proposed a subjective critique (which this discussion is primarily based upon) explaining why foam-drying techniques are not commercially used. As they see it, the primary reason is that foam drying is more expensive than conventional spray drying and drum drying. Therefore, if a satisfactory product can be obtained from any of these methods, there is no incentive to use foam drying unless it produces a better quality product. Further, foam drying is not as unique as the still more expensive vacuum freeze-drying process, which dries solid material better than any other dehydration method. Therefore, in the future foam drying will probably be directed toward specific types of products, namely relatively expensive, heat-sensitive fluid materials. In fact, this is the general direction foam drying has taken in the past.

When all aspects of foam drying are considered, it is a relatively rapid process that does not require high temperatures. While the foam structure of the product assures its rapid reconstitution, this same structure presents a storage problem since foam-dried products are bulkier than those processes by other dehydration methods. Aroma retention is another problem and odd-back techniques are required for some products. Corn syrups have been found to prevent undue hygroscopicity.

There have been two major modifications of the original foam-drying process. The first is the "crater" method, in which a layer of foam about 1/8-inch thick is spread on an aluminum tray with 1/8-inch diameter holes. A blast of air is shot through the holes in such a way that craters are formed in the foam sheet. This enlarged foam surface allows for an increased drying rate. The second modification is the "spaghetti" method. Strips of foam are extruded onto a plate, increasing the surface area and thus the mass transfer. The highest throughput is obtained when threads of the thinnest diameter are dried at the highest possible temperature. Either process produces a product with very low density. The density is increased by passing the powder through heated double roll compaction units which removes the very fine air bubbles that tend to show up in the reconstituted liquid. Density is also desirable because it makes the product easier to handle. (Holdsworth, 43)

There are several methods of foam drying. What was originally known as "vacuum-puff drying" has been converted into a continuous process called "continuous vacuum-belt drying." This method was originally used in the production of instant coffee and soluble tea, but the development of successful and significantly cheaper spray-drying techniques for these products has caused vacuum dryers to be replaced with spray-dryers. The vacuum-puff dryers are presently used for processing citrus and other fruit beverages, which are relatively expensive commodities. Citrus products, however, have not been amenable to more conventional dehydration techniques. Recently, with more success, the Eastern Regional Laboratory of the USDA test-marketed a vacuum-puff dried milk that could be sold at about a 21¢ per quart equivalent. The "milk" was packaged under nitrogen in cans containing the equivalent of one quart of fluid milk and was called "Dairy Fresh." The product sold well for a new item, indicating a good potential for commercial success. Further, consumers rated it favorably with regard to dispersibility, storage convenience, cost, and richness; in fact a great majority considered it as good as or better than fresh whole milk in all regards. Curiously, the sales of "Dairy Fresh" seemed to have no effect on the sales of other dairy products. Apparently, it was purchased for special uses, thus suggesting additional markets for milk. The USDA has proposed a plant that would operate 24 hours a day, 250 days a year, and produce 62,000 quart equivalents of "Dairy Fresh" each working day. The product would be packaged in No. 10 cans for institutional use. Of course, the price of 21¢ per quart equivalent would probably have to be higher now because the higher price of raw milk would influence the selling price. However, if product quality and storage stability are as good as they seem to be, "Dairy Fresh" is a potential application of vacuum puff drying. (Sinnamon, et al., 59)

A second method of foam drying, foam-mat drying, is similar to the vacuum puff method except that the foam is initially formed by agents and then dried under atmospheric pressure. Successful use depends upon producing a foam of suitable structure, i.e., one with many small, uniform, stable bubbles. The structure of the foam material permits high initial rates of water removal, as well as a relatively short dehydration cycle. Also the process requires only moderately low temperatures. This type of foam should retain its structure during drying. With the exceptions of egg whites, beef extract concentrate, and whole milk concentrate, it is often necessary to use film-forming additives such as solubilized soy protein, glycerol monostearate, and sucrous palmitate, to stabilize the foam. Initial work in this area was based on tomato paste, but now it includes milk products, coffee, pineapple lemonade, grape and orange juice, apricot puree, and a prune product containing egg albumen. (Holdsworth, 43) In addition, a recent study on the commercial feasibility of foam-mat dried instant orange juice gave promising results. (Berry et al., 9)

The usual need for foam stabilizing agents retards the commercialization of this process. These additives, especially glycerides of fatty acids, may impart an objectionable flavor to the product as well as altering the appearance of the reconstituted product. However, this problem is minimized by compacting.

Several attempts have been made to develop a continuous process of foam-mat drying for commercial use. Two basic methods were developed: a moving stack-tray system and a continuous belt system. One particular commercial unit utilizing the stock-tray system experienced serious mechanical problems, such as tray warpage, which impeded product removal by scraping. This, coupled with the inability of this particular system to attain an economical production capacity, led to its abandonment, although the complicated mechnical handling procedure of the stack-tray system can be eliminated with the continuous belt system.

Product recovery losses, which may be as high as 12 or 15 percent, are another potential problem of foam-mat drying. Although less extensive, the problem is present with solid belt dryers as well as tray dryers. However, the loss could be substantially minimized by controlling doctoring more closely or by eliminating continuous belt washing. (Hertzendorf and Moshy, 41)

Another method, Microflake dehydration, consists of drying a continuous sheet of foam 20 ml thick that has been placed on a continuous stainless steel belt. The latter is heated from below by steam and from above by a high velocity air stream. Drying time is reported to be about 1/10 that of the standard drying process. To produce a powder with 1.5 percent moisture content a temperature of approximately 170 degrees for one minute is required. One commercial unit is drying 30 million pounds of powder per year using the

Microflake technique. The quality of foam-dehydrated food has been on a par with that of vacuum-dried products, and for some items, even freeze-dried products. Although this method was first applied to orange juice, the company is also licensed to produce lemon, lime, grapefruit, pineapple, grape, banana, peach, and tomato crystals.

Foam-spray drying is different from the methods already described. Foam-spray drying is an extension of spray-drying and therefore requires only minor modifications of conventional spray-drying equipment, such as the addition of a gas supply, gas feed, and a mixing system to the dryer feed line. Foam-spray drying is used for product density control, for it decreases density by a factor of two. In conventional spray-drying, the powder is made of a hollow sphere surrdounded by thick walls of dried material. However, the foam process produces particles having many internal spaces and relatively thin walls: therefore, the product reconstitutes more rapidly. (Hertzendorf and Moshy, 41; Holdsworth, 43)

The problems involved with storage stability of all foam dried products have not been completedly solved. The porous structure of these products causes them, in the presence of oxygen and/or moisture, to have undesirable reactions which result in off flavors and the deterioration of the product. Therefore, special storage conditions are often necessary. For example, the USDA recommends storing vacuum-puff dried whole milk powder under vacuum conditions. Further, certain products must be packed in an essentially oxygen-free atmosphere which not only limits packaging possibilities, but also increases costs.

Low moistures in foam-dried products must be obtained either directly during the drying process, during a finish drying step, or during a conditioning period in a dry atmosphere. While some researchers, like Holdsworth (43), advocate silica gel and alumina as suitable in-package dessicants, others feel that these dessicants will probably not be acceptable for a consumer product. Product hygroscopicity is, therefore, a serious problem, and although compaction techniques are helpful in reducing hygroscopicity ultimately foam dried products may require suitable single portion packaging. (Hertzendorf and Moshy, 41)

Furthermore, if low-moisture products cannot be obtained by drying in all cases and if conditioned storage is required, the producer will need to maintain large product inventories. This will greatly increase storage and warehousing costs.

In conclusion, foam drying will probably not be a broadly applied dehydration technique, but rather one used for specific products. Once the food processing industry becomes convinced that these products have a market, foam drying will no doubt be adopted when relevant.

Drum Drying

A third method of dehydrating liquid foodstuffs is drum drying. For this process, a layer of wet material is deposited on the surface of one or more revolving steam-heated drums. The system has the capacity for a very high rate of heat transfer, but this also creates the problem of heat damaging the food. However, short residence times and reduced pressures can lesson the danger. Both a high rate of production and a low moisture content can be achieved by operating at a high temperature. However, the drying rate is often limited by the temperature tolerance of the product.

At present drum drying is used very little. Milk is no longer dried this way; spray-dried milk is a more acceptable product. But some potato flakes are drum-dried, as are a large percentage of the readily rehydratable cereal products, such as baby cereals and "instant" cereals. Laboratories both here and abroad have developed processes for applying the method to fruits and vegetables, but thus far commercial success has not occurred. One project studied the effect of some equipment modifications on the quality and stability of finished tomato puree. Because of a partial shroud and a low-humidity collection zone, the product could be inexpensively processed by drum drying. The product was removed from the drums with a high moisture content of from 5 to 7 percent, which yielded a superior product because there was no scorched flavor or color damage. Bin-finishing to a target moisture of from 2.5 to 3.5 percent required only three to six hours with forced air at 95 F and a 6 percent relative humidity. The product was stable for six months when air-packed. Since it can be dispensed from reclosable containers without caking, instant tomato sauce is available to the housewife or the manufacturer in any amount or consistency. The researchers estimate that for a commercial system starting with 20 percent solids, using a 3.5 by 10 feet drum dryer with 3.5 by 5 by 3 finishing bins, and producing 350 pounds per hour, the cost would be 4.5¢ per pound of dry tomato puree. (Lazar and Miers, 49)

Frozen Foods: The Fastest Growing World in The Universe of Food

> "The fastest growing world in the entire universe of foods is the frozen food world.... Frozen foods will be the number one gainer in the food industry in the seventies." (Karnes, 45)

> "Everyone knows that prepared frozen foods are the wave of the future and that the time may come when stores are filled with heat-and-eat specialities instead of raw commodities" (Katx, 46)

> "Many operators in all segments of the food service industry--both commercial and institutional--report using 25 to 80 percent frozen foods in their menus. These operators also expect to be increasing their use of frozen foods as much as 40 percent by 1974." (Angione, 6)

These three quotes are examples of the general mood characterizing the frozen food industry. Without a doubt the industry is growing rapidly. The total sales in 1972 were up a phenomenal 13.6 percent--the biggest jump in ten years--with strong gains being chalked up for everything but frozen fruit (see Tables 1 and 2). Production also achieved a near-record gain of 6.7 percent, including a very remarkable increase in the packing of frozen foods for the institutional market.

TABLE 1

Value Of All Frozen Foods* From 1942 Through 1972

1942	$ 162,000,000	1957	2,362,000,000
1943	178,000,000	1958	2,320,000,000
1944	197,000,000	1959	2,749,000,000
1945	257,000,000	1960	3,037,000,000
1946	324,000,000	1961	3,638,000,000
1947	245,000,000	1962	3,960,000,000
1948	292,000,000	1963	4,381,000,000
1949	375,000,000	1964	5,246,000,000
1950	500,000,000	1965	5,765,000,000
1951	700,000,000	1968	7,033,236,000
1952	875,000,000	1969	7,641,114,000
1953	1,200,000,000	1970	7,931,000,000
1954	1,450,000,000	1971	8,128,000,000
1955	1,700,000,000		
1956	2,106,000,000	1972	9,230,000,000

---

*Includes all sales of frozen fruits, vegetables, concentrates, poultry meats, seafoods, and prepared foods at conservative retail prices or at average prices paid by institutions and reprocessors. As a generality, it can be said that retail sales make up 65% of the total figure, but this percentage fluctuates so greatly from product group to product group that it cannot be used as a rule of thumb. Of sales made through retail stores, frozen food chains with two or more stores account for 70% of the business.

From: Quick Frozen Foods (December, 1973) 36(5): pg. 46.

In the same year, institutional foods led the way in both sales and production increases with a 9.2-percent rise in the volume of frozen foods bought by the food service sector. Private restaurants, chain operators, and hospital directors now accept red meat that has been quick frozen, as well as frozen turkey products, for example. But despite the fact that the food service field, especially in the area of airlines and contract feeders is switching to frozen convenience foods in increasing numbers, retail sales still account for most prepared frozen food production (Katz, 46)

Fish and seafood entrees are the most popular frozen foods because they are more convenient and available than fresh fish or fish that is preserved by other methods. (Foda _et_ _al_., 28) Also, both retail and institutional consumption of frozen vegetables (notably potatoes, green beans, lima beans, and green peas) moved ahead vigorously in 1972, although the increase was more marked on the institutional side. And although the overall sales of frozen fruits declined in the same year, frozen apple sales to the institutional sector were up, (Katz, 46) and food service directors in all sectors of institutional feeding say they are now beginning to use more pre-prepared frozen fruits because they save time. (Foda _et_ _al_., 28) The biggest sellers in the food service industry now are frozen hamburger patties, breaded fish portions, potatoes (especially french fries), onion rings, cream and fruit pies, juices, and poultry. These items will probably remain as important throughout the seventies. (Havighorst,35)

There are several reasons why food service operators are using frozen foods. First, many frozen food processors are making exciting

TABLE 2

1972 Frozen Food Poundage and Dollar Values

	poundage (lb)			dollar value ($)		
	Retail	Institutional	Total	Retail	Institutional	Total
Prepared Foods	3.398B	683M	4.081B	$2.290B	$402M	$2.692B
Seafoods	502M	832.7M	1.134B	$626.5M	$1.151B	$1.77B
Poultry	1.712B	606M	2.318B	$894M	$320M	$1.214B
Vegetables	2.119B	2.925B	5.044B	$706M	$786M	$1.492B
Meats	372M	633M	1.005B	$380M	$575M	$955M
Juices & Drink	1.619B	407M	2.098B	$710M	$132M	$842M
Fruits	70M	627M	697M	$41M	$217M	$258M
Total	9.864B	6.714B	16.578B	$5.617B	$3.583B	$9.230B

Adapted from: Quick Frozen Foods 36(5): 46-47 December, 1973 new convenience products that are tailored to the needs of the food service operators (Foda et al., 28) If purchased, stored, and prepared properly, these products are usually of high quality, an important factor in their popularity. (Havighorst, 35) Second, frozen foods reduce labor costs and save on equipment purchases--partly because they dictate exact portion quality and often quantity. Third, seasonal products are not often "out-of-stock." Finally, since frozen foods usually require less preparation, faster service and faster inventory turnover are possible.

Slow vs. Rapid Freezing

Still, probably the most important factor determining sales is the quality of the product. In order to maintain texture and organoleptic properties of a frozen product, a continuous freezing process is necessary. However, freezing will always induce major alterations in foods such as death of tissue with loss of consistency, drip of cellular fluids and altered organoleptic properties. The best method, then, involves limiting the size of the ice crystal, preventing the development of long ice needles, and reducing the disruption of cells to a minimum. This will, generally, be done by fast freezing the food to low temperatures in order to stop biochemical and enzymatic activities. Rapid freezing is recommended for fish and meat, for example, because large ice crystals may have disrupting effects on the fine tissue and because strong hypertonic fluids which develop in the course of freezing could destroy the physical-chemical equilibria if allowed to stand for too long. Also when specific aromatic or nutritional properties need to be maintained, as in fruit juices, milk, tea and coffee extracts, the main problem is to avoid, during processing, denaturation of the substances responsible for taste and aroma since this might result in unbalancing the flavor of the products when they are brought back to utilization temperatures. All these examples illustrate that usually a faster freezing rate produces a better quality product (Rey, 57)

In contrast, studying the effect of freezing rate on chicken meat quality, researchers found that slow freezing caused a larger loss in thawing drip of cellular fluids, a larger loss of nitrogenous constituents and nucleic acid derivatives, and a decreased holding capacity in the meat. On the other hand, fast freezing, inhibits proteolysis, preserves better the integrity of muscle proteins and induces no significant changes in the color, odor, and taste of uncooked breast or leg meat. Although this case cites a spectacular improvement in quality due to an increased freezing rate, not all products benefit from rapid freezing. (Rey, 57)

Freezing Methods

At the present time, there are a number of different methods of freezing available to the frozen food processor. *Air blast freezing* is the most versatile of the methods and has the longest history of commercial application. This method freezes the product in a storage room by using fans to circulate cold air. The obvious disadvantage of this method is that it takes a long time to freeze the product. Small packages freeze overnight, cased goods and barrels take many days.

The *air blast tunnel* freezer is an improvement over the first system. Using very fast air movement and air temperatures of from -35 to -40 F, it freezes the product much faster. This method is used primarily for packaged fruits, vegetables, bakery goods, meats, poultry, and prepared dishes. Packages are usually put on trays, which in turn are put onto dollies or trucks. With properly spaced shelves and packages, freezing time can be decreased to a few hours for many items. Some unpackaged items are also frozen this way.

A third method, conveyor tunnel freezing, is a variation on the second system. This system uses conveyors which move food on an endless belt or chain through a freezing zone of rapidly moving air at 35 F or CO_2 gas at approximately -100 F. Meat patties, chicken parts, bakery goods, and other individually proportioned foods, packaged or unpackaged, are frozen in such units. Freezing takes only a matter of minutes, and automated loading and unloading can be found in some of these systems.

Bulk freezing on conveyors is another method. In this system, such piece items as peas, cut corn, beans, etc., are piled several inches deep on a belt and passed through the freezing zone where -35 F air blows. The system permits storage of frozen food in bulk. Packaging is done later during a slack season or upon order. Freezing by this method is faster than freezing in packages, but not as fast as IQF (Individual Quick Freezing). Therefore, evaporative losses may still be undesirably high.

Fluidized beds are used to achieve a rapid IQF. In this system, air flows upward through the belt at a sufficient force to fluidize or practically float the food pieces. Thus each piece is continually moved and turned and all surfaces are exposed to the freezing air stream. This rapid freezing improves textural quality, and the shorter exposure to the freezing medium lessens evaporation. An added advantage of IQF is thawing. For example, instead of a restaurant chef or a baker thawing an entire 30-pound can of food, he can simply pour out the amount he needs. The IQF product will thaw quicker because only the individual items, rather than all the ice holding together a solid block, has to thaw.

IQF for liquid products is a very new concept. Such liquids as juices, purees, soups, pulps, and dairy products, may be frozen in a unit similar to an automatic ice cube maker to form pillow-shaped products. The advantages of this method over liquids previously frozen in a solid block include convenience in thawing and a cheaper package (perhaps a plastic film in a carton instead of the conventional metal can).

With plate freezers, heat transfer is by conduction (which in theory is more efficient than the convection methods already described). However, packaging the product partially offsets the advantage. For products that are packaged before freezing, such as asparagus, cauliflower, spinach, broccoli, and other irregularly shaped foods, plate freezing may offer the fastest practical freezing rate. The labor cost of plate freezing is potentially high because usually hand labor is required for loading and unloading, although modern plate freezers are highly automated and labor requirements are minimal. Such automation, however, makes a plate freezer even more costly.

The contact freezer is essentially a plate freezer of unpackaged goods. This system uses either a belt or a drum. One version uses a double-walled drum with the refrigerant circulating between the walls. The product rides on the outside of the drum, maintaining refrigerant-to-metal-to-product contact. Evaporation is virtually eliminated, maintenance is minimal, and losses due to the product's sticking to the drum or breaking when it is removed are claimed to be nil. However, this method is limited to uniform, flat or round materials that can be easily spread on a belt. Manufacturers have claimed that a one-inch thick steak can be frozen in 20 minutes and small shrimp in four minutes (Rasmussen and Olsen, 56)

The final freezing methods to be discussed are immersion and spray freezing. In both cases a liquid, rather than air, is the refrigerant. The advantages of liquids over air are twofold. First, a liquid is a far better conductor of heat than air. Therefore, a more rapid rate of freezing can be achieved, even though the liquid may be at a higher temperature than that normally used in air blast. Second, lower temperatures are available when cryogenic liquids, which will be discussed later, are used. As their names indicate, immersion freezers operate by immersing the unfrozen product in the freezant, and spray freezers operate by spraying the freezant onto the items. Alcohols, such as propulene glycol and ethylene glycol, and brine are the common noncryogenic liquids that have been used commercially for many years. These liquids have boiling points in the range of 0 F to -20 or -30 F, and they can be used effectively to freeze such large items as turkeys at a fairly rapid rate. Protective wrapping of the product is essential. The usual wrapper is a shrink-wrap plastic that forms a good barrier between the product and liquid and also permits rapid heat transfer. A new refrigerant, dichlorodifluoromethane (R12), was approved by the FDA on August 13, 1967, and has found commercial application. Although its boiling point is within the noncryogenic range, it freezes items at rates comparable with the cryogens and will therefore be included in the discussion of cryogens.

Cryogenic Freezing

In 1966, the United States had 35 cryogenic freezing operations. By 1969, the number had grown to over 100. Today, still more exist. To understand why the number of cryogenic installations has grown, it is necessary to examine the cryogens along with their advantages and limitations. Cryogenic liquids, those having boiling points below -100 F, include liquid nitrogen (LN), liquid air, liquid carbon dioxide (LCO_2), and solid carbon dioxide. As previously mentioned, dichlorodifluoromethane (R12), although not a true cryogen, is usually included with the cryogens. Cryogenic methods have been used mainly for freezing beef, sea food, and poultry, and to a lesser extent, for freezing bakery products, pizzas, onion rings, and commissary items.

Carbon dioxide. Carbon dioxide is a by-product of many chemical processes and is therefore readily available at a low cost, offering wide possibilities as a freezing agent. Carbon dioxide is most commonly used as dry ice or carbon dioxide snow, which sublimates spontaneously at -78.8 F. However the solid-to-solid heat-transfer is not as efficient as a liquid-solid system. This is why other systems, in which CO_2 is directed from nozzles onto the food, have been developed. In these systems a very fine snow mixes with the material. But here again, the sublimation of particles prevents intimate contact with the product, and can delay freezing. Furthermore, research must be conducted to be sure that a chemical reaction between CO_2 and the product will not harm the product. On the other hand, carbon dioxide snow is still used in large amounts in storing and transporting deep frozen materials. In all cases, the equipment is simple and highly dependable; and it requires little capital and very limited maintenance.

Liquid nitrogen. The most frequently used fluid in cryogenic freezing has been and still is liquid nitrogen, a by-product of the extraction of oxygen from air. Liquid nitrogen, which is widely available in the United States and other industrialized nations, has practically unbeatable qualities as a freezing medium. Its boiling point at atmospheric pressure is -320 F and its cooling capacity is quite adequate. In addition, liquid nitrogen exhibits complete chemical neutrality, has no toxic properties, can be manufactured with high industrial purity, and is easy to handle, since special containers have been developed to ship and store the fluid. Rey (5) provides this general description of a LN cryogenic freezer:

> A cryogenic freezer in which liquid nitrogen and carbon dioxide are used consists essentially of an insulated tunnel (sometimes vacuum-jacketed) with inlet and outlet openings protected from atmospheric moisture and air by the curtaining effect of nitrogen gas evolving from the inside. The materials to be frozen are placed on a screened belt and moved in a countercurrent of cold nitrogen gas coming from the ebullition zone and driven in forced convection by adequately placed fans. The objects are rapidly surrounded by a frozen crust and progressively cooled to temperatures close to -10 C. They then enter the spraying zone where they are in direct contact with LN for a short time. The outside temperature of the product falls rapidly and reaches -196 C (-320 F). The frozen blocks are then conveyed to an equilibrium zone where they are allowed to stand under cold nitrogen gas so that the temperature can homogenize within the material and reach an average of -30 F to -50 F, depending upon the treated substance. They are now ready for storage and transportation. The whole operation requires only minutes.

Besides their many technical advantages, these systems also have advantages that are operational, quality-oriented, and economical.

There are several operational advantages. For instance, due to the low freezing times, productivity is very high. Also the cryofreezer is readily compatible with other existing systems. When placed ahead of a blast-freezer, for instance, it can increase its productivity by 25 percent and prevent the excessive dehydration of the products by surface crusting. LN freezing cycles are also versatile and can be adjusted easily to each individual requirement.

The quality-oriented advantages are equally important. Rapid freezing insures better quality, better color and texture, lower drip, absence of mushiness, and almost no loss of weight by dehydration (0.2 percent as compared to between 3 and 10 percent in other systems.) Also, the nonreactive atmosphere of neutral nitrogen gas prevents surface oxidation and keeps bacterial growth or contamination to a minimum. (Rey, 57)

Last are the economic advantages. The initial capital investment is about one-third of that for a comparable mechanical system. (This is true for all the cryogens, not just LN.) Direct labor saving is estimated at 50 percent. Furthermore, freezer rooms, compressors, motors, and cooling towers of a comparable mechanical refrigeration system take from five to seven times as much floor space as the cryogenic freezer. (Finnegan, 27)

There are limitations, however. First, the rapid rate of heat transfer does not occur if the product is packaged first or if the product is a large one, like a whole turkey. It has been suggested that freezing irregularly shaped products in an open container instead of the usual closed box might remedy the first problem. Also, the extremely rapid freezing rate causes surfaces of poultry and meat to appear white due to light reflecting from extremely small ice crystals. Consumers do not like the color, despite the fact that less damage has been done to the meat due to rapid freezing. Another problem is that products will crack and even shatter if exposed directly to LN at -320 F. Therefore, most LN freezers use sprays rather than immersion baths. Finally, droplets of LN, as well as LCO_2 boil so intensely when in contact with the product that they are actually repelled. Consequently, nitrogen is mostly in the gaseous state while in contact with the product. This is why an equally rapid freezing rate can be achieved at much higher temperatures, at which the freezant boils only moderately, producing proper liquid-to-product contact. (Rasmussen and Olsen, 56)

Dichlorodifluoromethane (R12). The R12 system is the newest method to gain widespread commercial adoption. It has been introduced for the processing of such IQF sticky foods as cut leeks, diced onions, and raw peeled shrimp. A couple of dozen plants of capacities up to 20,000 pounds per hour are now in operation in the United States. Ideally, the fluorocarbon freezer, as proposed by the DuPont Company and designed by Lewis Refrigeration, should combine the speed of cryogenic freezing with the cost of air-blast freezing. The R12 is sprayed directly onto the food and reaches its boiling point (-30 C, -21 F) in an air-free atmosphere. The sprayed material is immediately crusted. It then equilibrates while the freezant drips off and finally evaporates. (Rey, 57) No product evaporation losses are measurable. (Rasmussen and Olsen, 56)

Since the R12 freezant is very costly, Rasmussen and Olsen (56) recommend that it be recycled. Great skill and care are required to to avoid excessive loss of the freezant, but losses are generally kept down to a minimum of 1.5 percent. However, even this small loss is important in the overall economics of the process and usually amounts to close to 50 percent of the operational cost. (Rey, 57)

Many countries are still reluctant to allow direct contact between the R12 chemical and the food. However, R12 research continues and there is a good chance that the method will be more widely used in the future (Rey, 57)

Product Applications of Cryogens

As previously stated, LN is the most widely used cryogenic liquid. It is used on a world-wide basis for freezing red meat, seafood, poultry products, prepared foods, and fresh fruit. In addition, a wide selection of delicate foods is now being frozen with LN in plants capable of handling several tons per hour. These foods include fish fillets, small fish, whole salmon, prawns, shrimp, lobster, meat products, poultry, uncooked pies and bakery products, whole mushrooms, tomato slices, precooked meal portions, cooked and fried egg white, and so on. (Although many delicate products are processed by cryofreezing, tomato slices still cannot be frozen without loss of texture. In a recent study, sturdy tomatoes--those that are being developed for use with machine harvesting--were immersion-frozen with liquid nitrogen. Although normal color returned upon thawing, the texture was markedly affected. However, the researchers feel that with improved cultivars and greater attention to the ripening stage, pretreatment, and thawing procedures, a greatly improved frozen tomato slice can be developed.) Just recently, liquid nitrogen has come into use for freezing such fragile fruits as raspberries, strawberries, peaches and cherries. (Salunkhe et al., 58) In all cases, the freezing is of the IQF type, which allows better domestic use of the products placed in large containers. (Rey, 57)

A process called "spray-freeze" uses a liquid-solid system of CO_2 to freeze products, especially whole peeled bananas, mushrooms, cherries, peaches, strawberries, sliced peppers, and shrimp. Another system called "Ultra-Freeze" is said to be able to freeze any food product--poultry, red meat, baked goods, pre-packaged meats, vegetables, even complete meals. (Finnegan, 27) A third system in which liquid CO_2 is first vaporized and used as a gas is now available. It has been found to work well for bakery goods.

On the other hand, the designs presently available for the R12 freezant are not suitable for spongy bakery products. These products absorb so much of the liquid freezant under the sprays that the R12 cannot be boiled off efficiently before the exit. (Finnagan, 27) Thus, the R12 is better suited for IQF of sticky products, as previously mentioned.

Several studies have been conducted to determine the difference in quality between products frozen by airblast, liquid nitrogen, or R12. In one study involving carrots, researchers found that R12 was clearly the most effective in producing frozen carrots which retained much of the textural quality of fresh carrots. Furthermore, the retention of a firm texture was found to be a function of the speed of freezing. With LN immersion freezing, there is a danger of shattering the carrots. However, the scientists noted that this danger might be minimized without slowing freezing to the rate of air-blast freezing if a spray application of LN rather than nitrogen vapor had been used. They did not, however, possess the equipment to test this conjecture. (Wolfod and Nelson, 64)

Another experiment used salmon steaks. This study suggested that their low loss of weight when frozen by R12 might be sufficient to offset the slightly higher cost of R12 freezing over conventional methods, such as LN-boosted air-blast and air-blast freezing. In addition, the rapidity of R12 freezing makes continuous in-line freezing possible with lower labor requirements than both conventional processes and should be of interest to processors of fish products. (Chen _et_ _al_., 22)

Improvements in product quality directly attributable to the faster freezing capability of cryogenic systems, vary from product to product (Hall, 34) For example, it is essential to freeze fruit very rapidly. Meats, on the other hand, although they benefit from being frozen rapidly, need not be frozen within a matter of seconds, as is the case with fruit. The cell membranes of animal products are more elastic and are not as easily ruptured.(Fuma, 30) In a few cases, product damage during thawing may wipe out the advantages gained through cryogenic freezing. (Hall, 34) All these factors must be taken into account when using cyrogenic freezing methods.

Cost of the Cryogens

The growth and sophistication of the freezing industry has placed new emphasis on selection of equipment to meet the processor's needs. Should he opt for a cryogenic system, he will find that it is more expensive than a mechanical system when the over-all cost is considered. However, cryogenic system costs can be lowered by large-scale usage, close proximity to a cryogen-supplier, year-'round operation, and freezer tunnel design with efficient heat transfer and a maximum utilization of refrigeration capacity. (Hall, 34) In any case, the major points to be considered with the cryofreezing system are operating cost, cost of the system, and freezant evaporation losses from the system. (Finnegan, 27)

When the in-line costs per pound of frozen products are compared, the new freezant R12 is the cheapest. The R12 freezant costs approximately 1¢ per pound of frozen product, provided the freezant is efficiently recycled and not lost. LN costs approximately 2¢ per pound of frozen product. (Finnegan, 27) LCO_2 costs almost the same as LN and therefore would have about the same cost since both LN and LCO_2 required 1 to 2 pounds of freezant per pound of product frozen. (Rasmussen and Olsen, 56)

The Future of Frozen Foods

By 1980, a 40-percent increase in frozen food sales to the food service industry is expected. This means that the food service sector will buy $2.98 billion worth of frozen foods. Frozen food distributors feel that the biggest potential for frozen foods in the future includes casseroles and gourmet dishes, baked goods, red meats, sea foods, and hors d'oeuvres. In the words of one frozen food advocate, "Frozen foods ultimately will determine the success or failure of food service operations. Rising labor costs and sky-rocketing operating costs will force the industry to use frozens in order to stabilize food quality and the expense of doing business." (Havighorst, 35)

Food Canning: The Most Familiar Method of Food Preservation

Introduction

Canned foods are full-moisture, ambient temperature, stable food products, regardless of the package form or preservation process used. Traditional canning--that thoroughly familiar food preserving process--may soon become an anachronism. Although thermally stabilized foods in rigid cylindrical packages are still the major product of the canning industry, other products and processes are rapidly gaining acceptance. Nowadays not all canned products are thermally stabilized. Carbonated beverages and a new group of still beverages are stabilized instead by a balance of acid, sugar, and preservatives. In addition, flexible pouches, shaped plastic tubs, bags, and other containers are supplementing the rigid cylindrical can.

The canning industry underwent marked changes in the 1960's. For example, the weight of the can metal and glass was reduced, and a wider range of products emerged. There was major progress in the canning of beer, carbonated beverages, and fruit-flavored drinks; in high temperature-short-time (HTST) processing and aseptic processing; and in such new canning materials as tin-free steel, aluminum, and other convenience containers.

In 1970, approximately one-third of the total weight of food packed in the United States was canned fruit, vegetables, meats, and other foods. Another 10 percent of the cans of beer and 13 billion cans of carbonated beverages were produced. Glass bottles accounted for an additional 16 billion fills of beer and 25 billion fills of carbonated beverages. Although pouches and plastic containers numbered only in the hundreds of millions in 1971, they already represented a lucrative business for several dairy and pudding firms.

The canning industry today is using new, higher speed equipment. One beer company, for instance, claims to have machinery capable of canning 1100 cans per minute. Two industrial reports boast production lines capable of 1000 glass containers per minute. Thus, as far as speed and reliability are concerned, the canning industry has far outstripped all other sectors of the food industry.

The results of most canning research appear in suppliers' reports, rather than in technical journals. The canners themselves generate the need for research, and the larger the canner, the greater the research and development effort made by the supplier. The only significant research and development in the 1960's that can be credited to the U. S. Government is flexible package retorting, completed in the early sixties. However, no significant innovations have been made in any USDA lab using this development; the extension of the work has been confined to small improvements, trouble shooting, and communications. Similarly, very little university research and development focuses on canning. Universities made no significant contribution during the sixties. Since the void must be filled, the canning industry and those closely related to it, conduct most canning research and development.

Since 1960, much research has centered on packaging. "Easy-open" aluminum ends on conventional cans and on all-aluminum food cans have been developed. Approximately 25 billion cans in 1970 had "easy-open" ends. A smaller, but still impressive number of aluminum convenience ends affixed by adhesive appeared on cans in the same year. A peelable, adherable, flexible polyester-aluminum foil combination also appeared, although it was not used primarily as a closure. Tens of billions of twist-off closures were used on bottles and plastisol-lined caps; twist-off caps, along with flip-open caps, are now as common as the wide-mouth glass jar. (Brody, 18)

Along with changes made in the types of closures on cans and bottles, packaging materials themselves have improved. The aluminum, iron, steel, and glass industries have all poured a great deal of time and money into developing high quality packaging for food products. (Brody, 16) The aluminum companies, for instance have tried hard to promote their metal as a commercial canning material but they have met with many difficulties. One problem is that the existing giant canning and food corporations have enormous investments in their current equipment and methods and are reluctant to discard them. The aluminum can is light weight and easy to work, but it dents and abrades easily. It is also non-degradable, but it is the only metal used for cans that is valuable enough to recycle. Further, aluminum cans do not operate interchangeably with steel cans because of the weight difference and the tendency of the aluminum to bind on steel railings. But aluminum companies have not given up. Because aluminum cans couldn't be made by the soldered side seam technique of the "old" can the companies developed a drawn-and-ironed can in the shape of a deep, seamless cup. These cans now come in many different sizes and shapes. Also, the industry has found success in producing aluminum for easy-open closures. Their most popular closure uses an aluminum end scored for easy tearing.

and generally, an aluminum insert is used on a tin-free-stell can end for a peelable metal tab. (Brody, 18)

Meanwhile, research scientists affiliated with iron and steel interests have been busy eliminating tin from steel surfaces and applying such non-tin layers, as chromium or chrominum salts coated with organic materials, to protect the steel. These cans were designed specifically for beer and soft drinks and demand to date has far exceeded supply, with the result that little research is being done to develop tin-free steel containers for other food products. In the brewing industry, the exterior of the can has a wraparound lithography to protect it against rusting. Packers and other foods often do not know exactly what is to be written on the outside until the time of packing. This problem also holds back its application of the wraparound can to other products. Further, there has been a question as to whether the thermoplastic adhesives used for the side seams can withstand the temperature used in thermal processing. (Brody, 18)

Most of the major steel companies are also working on a two-piece, draw-and iron steel can. This can is cheaper and less likely to leak than the two-piece aluminum can. The perfection of the can is apparently still some time away, although prototypes have been made. (Brody, 18)

The glass industry has developed standard, lighter-weight bottles with improved break and chip-resistance but the adoption of convenience closures, such as screw-on aluminum caps, has caused the greatest recent increase in the use of glass. (Brody, 16)

The composite spiral-wound can of fiber polyethylene-aluminum foil, which has a major share of the juice and juice drink frozen concentrate business, is another type of container. It has been successful in packing shortening and coffee, and since it is cheaper than the all-metal can, researchers will no doubt continue to study the feasibility of adopting it for other products. (Brody, 18)

Aseptic Canning

One of the newest innovations in the canned foods industry, however, is aseptic canning. With this method, a food processor can now offer a sterile product without the noticeable changes in flavor, texture, and appearance that are usually associated with thermally processed foods. (Anonymous, 4) Aseptic packaging involves filling a pre-sterilized container with cold, sterile food then closing it with a pre-sterilized cover all of which takes place in a sterile environment. Thus the package is hermetically sealed. (Brody, 17)

The biggest recent success story in aseptic canning is the "snack pudding boom." These milk puddings are individually portioned and aseptically packaged in two-piece drawn aluminum cans with convenience full-panel, pull-off tops. These snack packs, which usually come in packages of four, were introduced as lunch box desserts. But they also filled a consumer demand for quality convenience desserts. Within two years, the demand for these cans exceeded the country's capacity to produce and aseptically package them with pudding. The incredible growth of snack puddings between 1968 and 1970 drew almost every major food marketer into the field, and there has been a forecast of sales to two billion snack puddings by 1975. Although the latter prediction will probably not be met (700 million is a more realistic estimate), this use of aseptic packaging is still very important and many products other than puddings are now being packed. (Brown et al., 19)

Advantages to Asceptic Canning

There are several advantages to the aseptic canning process. For instance, in the traditional canning process, where foods are sterilized in their cans, many products tend to be overcooked by the time sterility is achieved, which affects their palatability, color, texture, and nutritive value. Their edges are often overcooked because their inside cores must reach and maintain a certain minimum temperature for a specified time. During this process, the contents at the edge of the can are overheated. In contrast, aseptic canning sterilizes the product outside of the can using HTST (high-temperature, short-time) methods, which are based on the following principles: (1) the microbial destruction rate increases by a factor of 10 for each 18° F temperature increase; and (2) biochemical reactions affecting color, flavor, and nutritive value increase by a factor of about two for each 18° F increase. Higher temperatures thus require shorter sterilization time, and the result is usually less thermal damage. (Brody, 18) With aseptic canning, the product is sterilized for a few seconds in a continuous flow heat exchanger at from 280 to 300° F before packing. Sterility is achieved with very little cooking. The product is then poured into a sterilized container and closed, all under aseptic conditions. (Brody, 40) Hence palatability, color, texture, and nutritive value are actually improved in most foods processed this way, which means that more delicately flavored products can be packed into cans. (Bird, 10; Brody, 40)

Two independent studies have evaluated the chemical and quality changes of strained peas (Davis _et al._, 23) and strained carrots (Luh, _et al._, 52) canned by both the aseptic and the retort processes. In both cases, the aseptic process was superior to the retort process in maintaining a high level of free amino acids and amino nitrogen in the canned product. Further, the retort process was shown to produce acidity and thus perhaps to influence the stability of the five nucleotides in the canned product. The aseptic (HTST) process appears to retain nucleotides are known to have a flavor-enhancing effect on canned low-acid food. In the carrot study, the aseptically canned vegetables were far better in flavor and thiamin retention than those processed by the retort method. (Luh, _et al._, 52)

A second advantage related to product quality is that nutrients, flavor, or color lost in heat preserving may be re-added to the product before the can is sealed--an impossibility in the usual retort canning procedure. Using re-adding procedures, it may become possible to retain nearly all the nutrition of the fresh production of a canned food. (Bird, 10)

Also, aseptic canning provides for more precise temperature control during heat processing. For some products, like dairy-type puddings, this factor is critical. In kitchen preparation, overcooking the product at the edges is prevented by stirring. Although agitation is impossible in retort canning, stirring and mixing are easily accomplished in an aseptic system. (Bird, 10)

A fourth advantage is that quality is independent of container size, a significant consideration in catering and institutional feeding. (Brody, 40) Previously, getting heat into the center of a large institutional-size food container was a problem. Since aseptic canning solves this problem, certain aseptically canned foods may first become popular in institutions. (Bird, 10) Already, ready-meal items in large cans have had substantial success with the catering businesses of the United States. (Brody, 40) Also, California Canners and Growers have developed a new aseptic process for fruits and vegetables. This system mass packs fruit and vegetable particulates in 55-gallon drums. The 55-gallon drum is comparable to 75 No. 10 cans. The developers feel that this method offers several advantages over freezing with which this process was developed to compete. For example, aseptically canned products are more easily shipped and stored than frozen ones, representing a cost savings to customers. Also. no thawing is necessary, and products packed this way taste like fresh fruit.

Another author has suggested 55-gallon containers for such foods as ice cream mixes, puddings, banana puree, apple slices, peaches, and other low-acid foods. (Bird, 10) However, handling a drum weighing 500 pounds in an institutional kitchen may be a problem, and in any case, only after these drums have been tested in institutions can their true potential be realized. (Anonymous, 1)

Limitations to Aseptic Canning

At the moment, though, certain limitations are evident. Aseptic packaging is still confined commercially to fluid and near-fluid materials and it is possible that aseptic canning might be used only for these types of foods for some time in the future. (Brown et al., 19) Some liquids with suspended solids up to about 3/4-inch cubes have been successfully processed; however, there are two basic problems in aseptically canning food products with particulate matter. The first is providing a mechanical means of physically handling such products in a continuous heat-hold-cool-fill operation, while maintaining proper distribution and integrity of the particles. However, this problem is being successfully dealt with by equipment designers and food technologists. The second problem is insuring the sterilization of the entire particle while taking advantage of the HTST process for maximum preservation of other product qualities. To complicate the situation further, it is very difficult to measure the temperature in the center of a small particle suspended in a liquid carrier as it moves through the scraped-surface heat exchanger in an aseptic system. In-line research is not the answer, but two researchers have suggested a mathematical approach to evaluating the system. They note that the benefits of HTST processing for quality preservation will diminish as the size of the particle increases and holding time decreases. Better products may therefore result from longer holding temperatures when large particles are involved, depending on the objectives. (de Royter and Brumet, 24)

Current Products and Processes

By 1973, aseptic techniques were being employed in some sixty U. S. food plants for packaging dairy-based products, including fluid milk, egg nog, yogurt, liquid coffee whitener, and puddings. Growth during the previous decade had been rapid. At the end of 1970, 61 aseptic canning lines were in 23 U. S. plants. Over 40 of these had been installed since 1965. Of the 23, only 18 were owned by actual food companies, such as Borden, Carnation, Del Monte, Gerber, Land O'Lakes, Libby, Mead Johnson, United Fruit, and General Mills. The remainder were contract packagers who specialized in aseptic processing. (Brody, 18)

Advances are being made in packaging as well. The conventional rigid metal can is no longer the only possible container to be used with the method of sterile packaging. Researchers are experimenting with glass, metal drums and pails, and flexible and semi-rigid containers, such as laminated plastic pouches, formed portion-control plastic containers, plastic bags-in-boxes, and paper board cartons of tetrahedral or rectangular shape. (Brody, 17)

Recently, higher-speed aseptic canning system processing about 450 cans per minute (a speed necessary for line efficiency in commercial operations), became available and is proving to be an important advancement in aseptic canning equipment. The aluminum two-piece draw and redraw single-service can with easy-open full panel pull-off cover, which has become popular (especially with the "snack puddings") recently, poses some problems. However, some of these problems have been solved in the mechanical design of the equipment. Also, innovations with respect to high temperature external and internal coatings for both can and cover have been developed. (Brody, 17)

Aseptic packaging in glass containers has not yet become possible because of thermal shock and other problems. However Dole, the company that produces the only commercial equipment available today for aseptic processing, may be close to perfecting equipment which will allow glass to be used as well (Brody, 17)

The Fotra Pak system, with its tetrahedral paperboard-foil-polythylene lamination carton, is a Swedish development which has found some acceptance in Europe, Asia, and Africa, particularly for fluid milk and cream. Some single-servicing coffee whiteners in the U. S. also use this package. The other type of paperboard carton, a rectangular one, is used by both Tetra Pak and the Ex-Cell-O Corporation (Pure Pak) for sterile, flavored milk. An article describing the Pure-Pak System of aseptically packaging products in rectangular paperboard-plastic-foil gable-top containers has recently appeared.(Hendrick, 37) This article discusses the commercial use of the Pure-Pak system at the Beverly Farms in Pittsburgh, Pennsylvania. Beverly Farms uses the system to package table cream, whipping cream, eggnog, half and half, and chocolate milk aseptically. The products have the same flavor as before processing, but they last much longer. For example, milk, chocolate milk, and eggnog will remain usable for 30 days at 50° F. The manager of Beverly Farms attributes his large increase in the sales of Pure-Pak products to this extended shelf life. (Henke, 38)

Similarly, liquid foods packed in flexible pouches also have long shelf lives. This method developed by the Continental Can Company involves using prefabricated, internally-sterilized sealed pouches which are passed through an ultraviolet tunnel for external sterilization. The pouches are then filled by needle injection and resealed below the puncture opening. (Brody, 17)

Aseptic packaging in rigid plastic containers is primarily adopted for products which are normally refrigerated or which naturally inhibit bacterial activity when stored at room temperature. Containers for these products are usually of the thermoform, fill, and seal type. These containers are attractive, especially to the processor who handles portion-packed items, because they are inexpensive and easy to process, use, and dispose of. Many sales are to restaurants and airlines and the plastic, single-serving, half-ounce coffee creamer has been particularly popular. Not only is it convenient for users but one dairy saves 25-80¢ per 1000 portions in container costs. Further, half-and-half coffee creamer, when packaged this way, was still sweet after two months of unrefrigerated storage. (Toledo and Chopman, 63)

Finally, about 2,000 dairies are using the new Bag-in-Box for bulk packaging milk and dairy products, with the result that dairy cans have been almost eliminated. Bag-in-box packaging is essentially aseptically packing a product in a plastic bag placed inside a cardboard box. Recently, this method has been extended to include bulk handling and processing fruits and tomatoes. Laboratories and pilot plants have experimented successfully with semi-processed tomato products, apple sauce, citrus and other fruit juices and purees, cranberries, and other particulate foods up to a half-inch in diamter which have been packed in both six- and 56-gallon aseptic barrier bags. Developers feel the bag-in-box method offers benefits. First, there is a 50-percent saving in container cost, since one six-gallon pouch contains the same amount as six No. 10 cans. Furthermore, an 8-percent weight saving in shipping also results along with reduced disposal problems. The 56-gallon containers have two fittings which permit rapid pumping of the product from the container. Finally, the six-gallon package, which is a convenient size for supplying products to the food service industry, permits sampling without destroying the container.

Despite all these new packaging materials, metal cans are still popular. For instance, just last year, Carnation introduced a new line of aseptically processed products in No. 10 cans for use by the food service industry--a line of "Chef-Mate" products including Sloppy Joes, Chili Con Carne (with beans and without beans), Macaroni and Cheese, and several sauces, just to name a few. (Anonymous, 3)

The Future of Aseptic Canning

Most canned foods probably will be unaffected by the aseptic process, for they are already being canned satisfactorily. But some foods cannot be canned at present, and it is with these that aseptic canning has a potential importance. For example, extremely heat-sensitive foods, including many dairy products, and foods that are sold only in frozen, refrigerated, or dehydrated forms may possibly be canned. In canned form, these products would be less perishable and less costly. And because aseptic canning allows re-adding, processed foods that need to improve nutrition, palatability, or appearance are also a potential market, as are low-acid foods that are difficult to preserve by the usual canning methods. Thus, the foods most likely to adopt aseptic canning are low-acid foods, vegetables, fruits and berries, flour mixes, eggs, milk, delicately flavored prepared foods, and some seafoods. (Bird, 10)

Retortable Flexible Pouches

Although not related to aseptic packaging, flexible retorting packaging is often confused with it. Initially, however it had many more problems. The products that were previously packed in flexible packages--dehydrated, frozen, refrigerated, high-sugar, or high-acid products--were not entirely free of microorganisms; they were also expensive, and their quality often "left something to be desired." (de Royter and Brumet, 24) But the U. S. Army Nattick Laboratories and the Continental Can Company are developing the packaging process and at the present it looks as though flexible containers have a future in the canning industry.

The retortable flexible pouch--also known as "Flexpack" and "Flexican"--appears to overcome the drawbacks of metal cans. By altering the surface-to-volume ratio of the package, food can be heat-sterilized with reduced thermal damage, and a flat package made of flexible materials should be less expensive than a flat metal can. Furthermore, the retortable, flexible pouch occupies less space than regular metal cans in shipment and on shelves because the wasted spaces between packages are eliminated. Finally, a durable flexible pouch would not injure the person carrying it and could be less susceptible to damage itself. Thus, the retortable flexible pouch would overcome the four major drawbacks of metal cans and satisfy the objective of the U. S. Army Natick Laboratories' program: shelf-stable, low-acid foods in lightweight, flat, low-cost packages that can be carried on the solider's body without the danger of the personal injury that might come with a rigid can. (Brody, 17)

Because both solid food and liquids were to be packaged, retorting after packing and sealing were investigated by the laboratories. (Brody, 16) The lamination developed for this package was polyester-aluminum foil-modified polyolefin . Polyester was used as an outer barrier because it is a tough material, less prone to abrasion and puncture damage, and so is more protective of the primary barrier material, aluminum foil. Modified polyolefin can form a weld seal even if partially contaminated by oily or particulate materials, and therefore it was chosen for the innermost layer. The major problems which have been largely overcome, have been seal integrity and damage to the body material, which, of course, might be more susceptible to penetration than a rigid metal can. (Brody, 16)

The prospect of high-quality shelf-stable foods in light-weight, low-cost, stackable packages has excited many food marketers. When these advantages are coupled with food products that are of higher quality because of the use of shorter-time thermal processes, the potential for a whole new range of food products for home and food service use is opened. (Brody, 16)

Even now in Western Europe, terminally sterilized flexible and semi-rigid packages of meat, pate, milk, prepared entrees, frankfurters, and vegetables are manufactured and placed in widespread commercial distribution. These packages have not revolutionized the food consumption habits of Western European homemakers and food service operators, but the products are universally accepted and are in common use. At present, however, the terminal sterilization of low-acid foods in flexible and semi-rigid packaging has not yet been approved by U. S. regulatory authorities. (Brody, 16)

Potential Developments

S. A. Goldblith, at the conclusion of a recent two-part article on the history of canning, listed five areas he felt would be important in the future of canning. He included thermally processed foods in plastic containers. Furthermore, it is now possible to have a number of low-acid products sterilized in plastic films at a reasonable cost. Goldblith also sees microwave energy as a possibility for thermally processing foods in the future, and he believes that a third area of potential is the development of aseptic canning systems for larger particulate matter. He mentions the development of the spin sterilization system, and he believes that the trend toward canning formulated foods in addition to simple commodities will continue, and as a result, many shelf-stable formulated foods will be processed using new technology as it becomes available. (Goldblith, 31; Goldblith and Karel, 32)

Intermediate Moisture Foods (IMF)

Intermediate moisture foods (or "IMF," as they are known among food scientists) initially appeared as pet foods, a "soft-moist" combination of meat by-products, soy flakes, and sugar, with an approximately 25-percent moisture content and a water activity of 0.83. Propylene glycol and potassium sorbate provide antimycotic activity (the glycol also serves as a plasticizer), and emulsifiers, salt and nutritive supplements are also added.

As pet foods, IMF have been very successful, accounting for 10 percent of total pet food sales, or about $100 million in 1969. (Karel, 44) But thus far, they have not been produced on a large scale for human consumption because of inadequate osmotic and preservative agents. (Karel, 44) The United States Military and NASA, however, are especially interested in developing IMF for several reasons: these foods are concentrated in weight, bulk, and caloric content; they are plastic and therefore easily packed and stored; they can be consumed immediately after removing their protective wrappers; their texture is closer to that of unprocessed food than freeze-dried products which are often harsh and dry; and their wholesomeness and safety does not necessarily depend on their containers (for instance, they could be conveniently air-dropped). (Brockman, 20)

The United States Government has distributed contracts that will enable major food processing companies to investigate intermediate moisture foods. But many additional studies will have to be conducted before the market potential of IMF can be ascertained.

Chemical Preservatives

Chemical preservatives are any chemical which when added to a food tends to prevent or retard its deterioration. Generally, table salt, sugars, vinegar, spices and their oils, and those substances incorporated into food by direct exposure to wood smoke are not included in considerations of chemical preservatives (Desrosier, 25)

Preservatives are not only necessary for intermediate moisture foods, but for most foods that are processed. Often the preservative is chemical. Some chemical compounds and non-nutritive materials have been used in foods for a very long time, resulting in many benefits to the consumer. The use of chemicals, however, has accelerated in recent years (although not especially as preservatives) largely because chemicals often provide a more sophisticated and efficient way of achieving and maintaining food quality. (Stewart and Amerine, 62) Also, there is an increasing demand for more attractive, uniform, and non-seasonal foods and the consumer's current insistance on convenience foods is placing greater emphasis upon all methods of preservation. (Desrosier, 25) Highly industrialized countries have developed many improvements in the technology of food preservation by heating, freezing, drying, and more recently, irradiating, which is in the early stages of application. However, these processes cannot be used with many foods, and with others they are only partially effective. Hence the use of chemical preservatives, alone or as supplements to other methods, is essential. (Goldblith,31) However, it is very important to note that with the spread of refrigeration and the development of dehydrated foods, chemical preservation is required less and less frequently. (Bernarde, 8)

Some of the oldest antimicrobial compounds remain the most widely used, despite their limitations. (Goldblith, 31) Regardless of tremendous efforts by chemists and microbiologists, they have found relatively few antimicrobial agents which are effective against a wide range of organisms and yet not toxic to man. (Stewart and Amerine, 12) Antibiotics have been extensively studied over the last twenty years as possible antimicrobial additives for food, but the possibility that man's unrestricted consumption of antibiotics might produce an artificial selection of harmful pathogens has discouraged their use. The sulfites also have an antimicrobial effect. Benzoates and parabens (p-hydroxybenzoate esters), some of the most common antimicrobial agents, have the greatest range of activity. They attack many spoilage bacteria, fungi, and yeast. Propinates fight mainly against fungi and one type of bacteria in bread. Sorbates act mostly on yeasts and molds. Other common agents in general commercial use in the United States include sulfites and their salts, formic acid, acetic acid and salts, ethylene oxide, and propylene oxide. With the exception of the parabens, the most widely used preservatives are weak acids or salts of weak acids. They exert their greatest activity on the acid side of neutrality due to the undissociated acid at the low pH. This action is generally inhibiting rather than lethal to the microorganisms. (Goldblith, 31)

Some of the compounds that are primarily used for other purposes also have a role in preservation. A few examples of such dual role compounds are nitrates, which are primarily used for color fixing in processed meats, and sulfur dioxides (sulfites), which in conjunction with dehydration and other types of processing prevent discoloration of fruit and vegetables.

Besides the antimicrobial agents, other types of chemicals are often necessary if the product is to have a reasonable storage life. They include antioxidants, sequestrants, and to a lesser extent, acidulants. While microbial deterioration is one of the most important factors in preserving foods high in carbohydrates and protein, oxidation is the chief concern with fatty foods. Antioxidants play an important role in the utilization of fats and oils in modern food processing and in the marketing of foods containing fat. Antioxidants will not enhance a product of mediocre quality and they impart no flavor, odor, or color to the food. Only when they are used with good raw materials, correct processes, and proper packaging and storage conditions will a quality product result.

The most commonly used antioxidants contain various combinations of BHA, BHT, and/or propyl gallate, together with citric acid in a suitable solvent. These compounds are much more potent than tocopherols, gum guaiac, and similar natural antioxidants. Generally, a 0.02-percent level of antioxidant based on the fat content of the food is permitted by the FDA. In dealing with fatty food, synergists, such as citric acid and phosphoric acid, are often used with antioxidants to increase shelf-life. The technology of fats and fatty acids has now advanced to the stage where rancidness is no longer the limiting factor of shelf-life. (Goldblith, 31)

Sequestrants are added to foods to bind up certain trace elements of metal, like copper, iron, and cobalt, and to render these metals chemically inactive. If uncontrolled, these trace elements can lead to premature deterioration, off-flavors, loss of color, and clouding. A sequestrant gaining wide popularity in the food industry for its ability to prevent or significantly reduce discoloration, clouding, and rancidness is EDTA. It is often used with an antioxidant, such as ascorbic acid, because the two work better together than either one alone. (Bernarde,8) Sequestrants have also been found to improve the clarity and whipping quality of gelatin, and their potential use in various food systems is now under study. In the future they will no doubt be used more frequently due to greater consumer demands for more stable foods and more imaginative new products. (Goldblith, 31)

Acidulants serve several purposes in the preservation of foods, besides contributing to their flavor. Canned fruits and vegetables, acidulants act both as sterilizing acids and as anti-browning agents which help to maintain normal flavor, color, and texture. Also bacteria and many other types of microorganisms are more easily killed in an acid medium. Adding acidulants to adjust the pH often shortens sterilization time, and sometimes lower sterilization temperatures are possible. Furthermore, acid prevents most microbial spores from germinating. (Anonymous,3)

These various chemical preservatives are at present indispensible and probably will continue to be used for a while, but they are becoming less essential as canning, freezing, and dehydrating methods improve.

Smoking

The preservative action of smoking comes from a combination of various factors. First, chemicals from the burning wood (small amounts of formaldehyde and other materials), have a preservative effect. Second, the heat helps to kill microorganisms and to dry the product, further contributing to preservation. However, since the advent of refrigeration, smoking is no longer depended upon to prevent spoilage. Today, instead, it is used to produce a distinctive flavor and is chiefly applied to four categories of products: meat and meat products; fish (fresh, salted or frzoen); poultry; and cheese. The major emphasis in the United States and Europe has been on smoking methods using large kilns through which fish or sausage can be moved by conveyors. This method uses fresh or frozen raw material and smokes it at a temperature of 80 to 70° C. for four or five hours. The final moisture content of the product is from 60 to 70-percent, and the flesh is juicy and tender.

Smoked meat keeps for a considerable time and has a pleasant taste, color, and texture. As previously mentioned, the lowered moisture content of the meat after smoking contributes to preservation, as do the smoke ingredients, which act against bacteria and fat oxidation. In today's modern, meat packing plants, smoking is scientifically controlled. The meat is hung on a rotating shaft and pushed up and down to obtain uniform smoking. Heat is applied by steam coils. Sawdust, blended from different hardwoods (usually oak and hickory), is burned over a gas burner. This smoke is then drawn into the shaft by suction fans. The most common smoked meats include ham, bacon, sausage, and frankfurters.

Fish is often both salted and smoked. Salt (or sometimes a direct dryer) removes some of the fish's water and this makes the smoking more effective. Frozen fish may also be smoked once they have defrosted. The leading smoked fish in the United States is salmon and the second is chub, a relative of the whitefish. Ocean herring is not smoked in large quantities in the United States, although it is the most important smoke-cured species in the rest of the world. Most fresh water fish and several ocean fish are hot-smoked; cold-smoking is usually limited to the fatty ocean fishes.

The smoking of cheese dates back to antiquity. Italian provolone and cheddar cheeses are examples of commonly smoked cheeses. Again, smoking aids in the keeping properties. Smoking causes drying and impregnates the rind with the antimicrobial and antioxidant qualities, which directly kills surface molds and other contaminating microorganisms.

Salting

Salt has many uses in the food industry. It is used in blanching water to tenderize vegetables before they are canned; it is used as a seasoning and as the freezing point depressant in brines for refrigeration purposes. Also, salt has an antiseptic and preservative role. Historically, food was often oversalted to preserve it and to disguise the spoilage. Salting for home preservation (mainly vegetables) had a major revival in Europe and the United States during World War II. However, the present trend is toward a less salty taste. Meat packers now supply milder cures for ham, bacon, and sausage and the salted fish industry has consistently reduced the amount of salt it uses. At the moment, refrigeration is replacing salt as a preservative for fish.

In butter, cheese, cabbage, olives, cucumbers, meat, fish, and bread, salt controls the microbial populations. The amount of salt used determines the type of fermentation, the organism that will grow, when the fermentation will stop, and whether the growth of certain undesirable organisms will be inhibited.

In pickling and dry-curing meats, various mixtures of salt, sugar, and sodium nitrate are used. Hams are either soaked in the "pickling" solution or receive it in an artery injection. The final salt content of hams varies from 3 to 6 percent. Corned beef that has been salt-cured usually has a 6.25 percent salt content; bacon has 2.25%, and frankfurters, 2 to 4 percent. Another way of treating meat and fish with salt is first to salt the product, then press and dry it. With modern cold storage, the primary objective of curing is to secure good color and flavor.

The slow fermentation of cheese would not be possible without salt to check the growth of microorganisms, except those responsible for flavor and the breakdown of fats and proteins. Salt is mixed with the curd of the cheese for flavor. It also aids in hardening, shrinking, and whey removing, which produces a desirable texture. Also, salt is still used in butter, although the main function is as a seasoning rather than an antimicrobial agent. In baking, salt is employed for both its seasoning properties and its ability to control fermentation. It retards and regulates alcoholic fermentation in bread to achieve a finer quality product. Too little salt will result in bread with a poor texture and flat taste.

In the future, salt will continue to be used for seasonings and for fermentation control. However, much of its use as a preservative will be shifted to refrigeration.

Sugars

Sugars are used in the manufacturing of jellies, jams, preserves, marmalades, molasses, honey, maple syrup, fruit syrups, liquid sugar, condensed milk, sweet pickles, candy, grape juice concentrate and other items. Sugar preservation is accomplished by concentration. Either water is removed by evaporation, as in the cases of juice concentrates and purees, or by the addition of sugar, in the cases of jelly, jam, preserves, etc. Sugar aids in the preservation when it reaches a concentration of 40 percent or more. The high osmotic pressure of sugar creates conditions that are unfavorable to the growth and reproduction of most species of bacteria, yeasts, and molds. However, if osmophilic organisms--those capable of growing under conditions of low water content and high dry matter--are present, spoilage may still occur. Generally, yeasts and molds are more tolerant of high sugar conditions than bacteria.

Sugar as a preservative is used mainly with fruits, particularly soft fruits. Apples, crabapples, apricots, plums, most edible berries, peaches, pears, nectarines, quinces, red and black currants, grapes, grapefruits, oranges, guavas, figs and pineapples are a few examples. Those products preserved by the addition of sugar are very much alike. Their individual characters depend on the kind of fruit used, the way it is prepared, the proportions of different ingredients in the mixture, and the method of cooking. The proper amounts of fruit, pectin, acid, sugar and calcium salts are needed to make a jellied fruit product. The fruits themselves supply the flavor and part of the pectin, acid, and calcium salts. The other indredients must be added. (Information on smoke, salt, and sugar preservation comes principally from Borgstrom, 15.)

Freeze Drying: So Far Only a Limited Commercial Success

Freeze drying has been used for preserving biological specimens for some time. In World War II, the method was used for blood plasma, and in 1950, the military first applied freeze drying to foods. Today, freeze drying is widely used for drugs, sera and vaccines, biological standards, vitamins, hormones, and other pharmaceuticals, as well as for instant coffee and tea, fruit juices and concentrates, and sea products (Rey, 57)

Freeze drying, also called lyophilization, is a two step operation in which material is first frozen hard to a low temperature and then dried from the frozen state by extracting the frozen solvent. (Rey, 57) In other words, freeze drying directly transfers the water in the frozen product from a solid state to a vapor state, by-passing the liquid phase. Usually this operation is performed under vacuum for high diffusion, although atmospheric freeze drying is also being researched. (Holdsworth, 43) The temperature of the sublimation zone for a material being freeze dried is held below the triple point temperature of the liquid in the material. Once the product is dried, it is removed from the vacuum chamber to a low-moisture packaging room where it is packaged (often in nitrogen or under vacuum conditions) in bulk or in smaller packages ready for the consumer.

Freeze drying has potential because it produces the highest quality product obtainable by any drying method; but freeze dried products are generally poorer than frozen or canned foods (Because the foods are dried, Bird (11) thinks it is fairer to compare freeze dried products to other dehydrated products, rather than to frozen or canned items.)

There are numerous reasons why freeze dried products are of higher quality than other dried products. First, one of the major benefits of freeze drying for many foodstuffs is the relatively good retention of volatile flavor and aroma. (King,47) However, due to high vacuum processing, there can be a large loss in volatiles during freeze drying. One researcher found a 75 percent loss in freeze dried carrots, compared to a 50-percent loss in canned carrots. However, he felt that freeze drying methods could be found which would solve the problem. (Henrick, 37) Despite losses, other methods of dehydration are, as a rule, inferior to freeze drying in this respect. (King,47)

Important reactions that lower the quality of food products are nonenzymatic or Maillard browning reactions. The deterioration produces color change (usually to brown) in the product, off-flavors, and in some cases, the loss of nutritional value, since lysine and ascorbic acid, for examples, participate in these reactions. The reactions are kept to a minimum during freeze drying for several reasons. First, in freeze drying where the dehydration process is carried out at low temperatures, the amount of degradation for a given amount of water removal should be less than in a product dried at a higher temperature. In addition to the low temperatures used, one of the greatest benefits of freeze drying is that it avoids browning those substances which show a peak browning rate at intermediate moisture levels due to relatively rapid transition from a fully hydrated condition to a low moisture condition as the ice front passes any particular point within the substances being dried. (King, 47) Also, lower moisture contents usually retard browning. Freeze dried foods are dehydrated to water contents below 2 percent then packaged in impermeable containers. This reduces the likelihood of significant deterioration in the product. (Greig,33)

One of the foremost advantages of freeze drying particulate foodstuffs is that the ice structure minimizes shrinkage, thus creating a porosity which eases vapor escape and enables rapid and nearly complete rehydration when water is added to the substance at a later time.

Unfortunately, freeze drying, although it has produced high quality products, also has its problems. First, it is expensive. (See Table 3.) Freeze drying costs anywhere from two to ten times the amount of other drying methods. However, if the freeze dried product is greatly superior to products dried by other methods, the consumer may accept the higher price, as he did in the case of freeze dried coffee. (Karel, 44)

But the cost of operation is not the only problem plaguing the freeze drying industry. Lipid, or fat, oxidation is another major problem. It is a deteriorative reaction which is particularly common in freeze dried foods because of their very large internal surface areas. The reaction is one between oxygen and lipid substances present in the freeze dried foodstuff. This reaction often produces a product with an off-flavor or rancid tastes. Therefore it is extremely necessary to remove oxygen completely prior to packaging many foodstuffs, as well as to use oxygen-impermeable packaging materials. (King, 47)

Table 3

Cost of Various Drying Operations

	Source 1	Source 2
	Approx. Cost ¢/lb	Total Drying Cost ¢/lb dry solids
Air	1.0-1.5	2
Drum	0.9-1.0	2
Spray	0.7-1.5	4
Foam-mat	2.3-3.0	6
Vacuum-puff	3.0-4.0	8
Freeze drying	5.0-10.0	15

All these factors increase the cost of production. The use of hydrogen and palladium catalysts as oxygen scavengers has been proposed, but the expense and complexity of such an approach are discouraging. (Bishov *et al*., 14) Also, the often fragile product must be protected against attrition. If mechanical protection is not afforded to freeze-dried particulate matter during handling and distributing, the product may be reduced to crumbs. Usually the protection comes from the packaging material.

The final problem involves texture changes following processing. Texture deterioration is one of the major defects in freeze-dried materials. Associated with this defect is decreased water-holding capacity, which results in loss of "juiciness." Therefore the product has a tough and "woody" texture. (Greig, 33) An increased aggregation of cellulose causes these changes in fruits and vegetables, as an increased aggregation of proteins causes similar changes in foods derived from the muscle tissue of animals (Greig, 33) This problem has been partially solved for meats by adding proteolytic enzymes to the rehydration water. However, tenderization is not always even. Sometimes the meat remains too tough and other times it becomes too soft. (Bishov *et al*., 14)

A series of palatability tests were made by the United States Department of Agriculature in the early 1960's. They compared freeze dried products with comparable canned or frozen products on the retail market. The results showed that the comparison meats were generally superior to those that were freeze dried. The biggest weakness with the freeze dried products was in flavor, followed by inferior appearance and lack of tenderness. Many freeze dried foods were considered tough, and probably some of this resulted from incomplete rehydration. Ten of the twenty meats tested were comparable in palatability with their counterpart products; two freeze dried soups were superior, the other eight products were inferior. None of the freeze dried meats rated an "unacceptable" score, although some received low ratings. But they may still have good commercial possibilities for uses in which they would be mixed with other ingredients that may cover up lack of flavor or off-flavor. (Bird, 13)

The major barriers, then, to large-scale applications of freeze drying have been the cost, the shelf-life of foods that are susceptible to oxidation, and the loss of juiciness in food derived from animal tissue (Karel, 44)

Microwaves and Freeze Drying

Comparatively rapid rates of freeze drying would be possible if heat could somehow be supplied to the sublimation front fast enough to maintain the maximum allowable temperature while a very low pressure is maintained in the drying chamber. Microwave heating offers the possibility of delivering the sublimation heat directly to the sublimation zone, thereby eliminating the problems of conducting heat from the surface of the material being dried. Because microwave energy quickly dissipates, it generates heat in a region of a high loss factor. Water has a much higher loss factor than the values for dried foods. If microwave energy could be dissipated rapidly enough in the frozen core of a food undergoing freeze drying, it might be possible to achieve the ideal combination of a very high internal mass transfer coefficient from low pressure and a maximum allowable water vapor partial pressure difference driving force, corresponding to the maximum allowable temperature of the sublimation front. (King, 47) Despite the potential, so far microwave energy has not been successful for use in freeze drying for several reasons. First, energy in the form of microwaves is very expensive. Second, there is the problem of glow discharge because of the ionization of gases in the chamber. Third, microwave freeze drying is very difficult to control. Localized melting produces a rapid chain reaction that results in "runaway" overheating. Finally, economical microwave equipment suitable for freeze drying on a large continuous scale is not yet made available. In view of all these limitations, microwave freeze drying is at present only a possibility of the future. (Karel, 44)

Freeze Drying Mineral Solvents

Up to this point, the discussion has centered on freeze drying aqueous solutions, but it should be mentioned that the use of CO_2 as a mineral solvent has been examined by the Nestle Company. Nestles has designed and built several installations for experimenting with the method--the latest of which is of industrial size. Several patents have been issued to Nestle that include the following two operations: extraction of coffee and tea aromas by liquid CO_2 at +20 C, stripping of coffee and tea aromas by hot CO_2 gas followed by condensation of the gas, and concentration of the aromatic solution. Nestle feels that the use of carbon dioxide as a solvent in the food industry is just beginning, and they are fairly confident that it will find numerous and important applications. (Rey, 57)

The Status of Industrial Application

In the early sixties, a great deal of money was spent on freeze drying systems by much of the food industry. Most of the experiences were unsatisfactory at best: the product and process failed to live up to expectations. As a result, many potential manufacturers became totally disenchanted with freeze drying. (Longmore, 50) Since then, however, the industry has learned more about the method and now a better and more uniform product is possible. The recent and rapid success of freeze dried coffee attests strongly to the fact that freeze drying has indeed arrived as a reliable process, yielding to a high quality dehydrated product which is attractive to the consumer. (King, 47) In fact, freeze dried coffee accounted for 20 percent of the total instant coffee sales in the United States in 1969 and 28 percent in 1970.

It has been suggested that traditionally spray-dried instant coffee will be entirely replaced by that of freeze dried and agglomerated instant coffees. (Karel, 44)

Application of freeze drying to other products has been relatively slow, with a few exceptions. Eggs are being freeze dried on a large scale by Affined Foods in Great Britain. This product has been competitive with frozen and spray-dried eggs for bakery use. In other plants in Europe, fruits and vegetables are being freeze dried for baby foods and soups. Some dairy products are also being freeze dried. (Spicer, 61) In Europe and Latin America, new plants are on stream for production of orange juice, as well as coffee.

In the United States, besides the expanding freeze dried coffee markets, most freeze drying activity seemed to be aimed at the institutional market and the governmental agencies, including the military. A spectacular development in terms of publicity has been the use of freeze dried items in space diets. The majority of entrees used on the Apollo flights were freeze dried. The menu for the Skylab Space Research Program uses sixty-eight foods, twenty-two of which are freeze dried. (Karel, 44). The freeze drying industry of today owes a great debt to the Engineering Command of the Armed Forces for both its initial and continuing development and testing programs. Aside from developing freeze dried foods for space rations, they also use freeze dried items for emergency rations, combat foods, and, occasionally, as regular mess items. Because these items are light and require no refrigeration, the Armed Forces buy them in large quantities for the special uses already mentioned. (Bird, 12)

Another small, but growing use for freeze dried foods is as "backpack" rations for hikers, mountain climbers, and other civilian consumers desiring the "instant reconstitution" and stability of freeze dried foods. At least six companies are producing these special-use foods which include various meat and fish items (beef, chicken, turkey, pork, tuna), a variety of salads, vegetables (including beans, corn, and mushrooms), soups, and fruits. (Karel,44) Some dry soups and prepared dishes have been produced on an industrial scale since 1959, with cooked chicken meat being the largest single meat item freeze dried. (Bishov _et al_., 14)

Probably the re-manufacturing market is the most likely outlet for freeze dried items for the next few years. In 1965, it absorbed more freeze dried foods than any other outlet. Most freeze dried foods going through this intermediate stage market will be blended with non-freeze dried items to make soups, stews, puddings, prepared meals, desserts, cereals, and may other products. (Bird, 12)

Still in the experimental stages are the following products: egg albumen, which is being freeze dried in an atmospheric fluidized bed (Maleck et al.,54); tropical fruit juices (guava, mango, passion fruit, and pineapple), which are being vacuum-puff freeze dried (Moy, 55); orange and guava juices, which are being conventionally freeze dried (Fox and Camero,,29); and freeze dried meat which will be added to fermented dry sausage (Lu and Townsend, 51). All of these products have been successfully produced in a lab, and more research is underway.

Conclusion

Thus far coffee is the only freeze dried item that has had commercial success, although other freeze dried products appear on the market from time to time. The widespread use of freeze dried items other than coffee has yet to be realized. Still, freeze dried products are considered high quality foods. Because they are processed under mild conditions, they retain the aroma, and they do not shrink like other products that are concentrated or processed by the diffusion of soluble components. (Holdsworth, 43) In spite of these characteristics, the problem of maintaining a uniform and reliable high-quality product in freeze drying is an important challenge which has not yet been met in a wholly satisfactory fashion. Researchers are still working on how to avoid uneven drying, how to have as high rate of freeze drying as possible without product spoilage, and how to recognize promptly the endpoint of drying. (King, 47)

Irradiation as a Food Preservation Method

Introduction

Irradiation, the processing of foods by radiation, is good for preserving foods such as oranges, strawberries, fish, potatoes, and other vegetables that are high in moisture content and very susceptible to rapid bacterial decomposition. (Bernarde, 8) When radiation speeds through food, it ionizes some of the atoms in its path and alters some of the vital macromolecules in the food system. This destroys bacteria and other microorganisms, but the food itself suffers no harmful effects. Although some vitamins are lost at higher radiation doses, the food is not made radioactive, and with low doses of radiation there is less loss of vitamins than in canning, freezing, or drying. (Urrows, 65) Radiation has also been used in food systems to destroy insects and parasites, to delay spoilage due to senescence in fruits and vegetables, to delay ripening in green bananas, and to inhifit sprouting in potatoes.

Radition from cobalt 60 or cesium 137 is usually applied in one of two dosages, radurization or radappertization. Radurization uses low dosages of radiation, (between 200,000 and 500,000 rads) which do not kill the bacteria, but rather reduce the bacteria level so that food will not spoil for an extended period. Furthermore, it does not alter the taste, odor, or cooking qualities of the food. Oranges and potatoes irradiated with these dosages were free from spoilage for two months when stored at 45 F. (Bernarde, 8)

Radappertization, on the other hand, uses higher levels, usually 2 to 4.5 millirads. The Armed Forces, who are interested in preserving food indefinitely without refrigeration, are investigating radappartization as a method for preserving combat rations. Their main interests are beef, ham, pork, and chicken that has already been cooked or smoked. (Pizer, 66) The Atomic Energy Commission, with more diverse interests, such as fruits, vegetables, finned fish, shellfish, and wheat, is also investigating the process which they feel will benefit the civilian consumer. The goal of both the Armed Forces and the AEC is to bring the techniques of irradiation to the point of technological and economical feasibility where private industry can apply them commercially. (Urrows, 65)

Although radiation-processed foods aren't for sale in the United States at the present time, research and testing involving thousands of human volunteers, will no doubt hasten the acceptance of irradiated products by the Food and Drug administration. (Urrows, 65) The volunteers, which included professional tasters, scientists, technicians, representatives of government and industry, soldiers, sailors, and airmen, all agreed that properly processed irradiated foods were acceptable to them. (Pizer, 66)

Under the Food, Drug, and Cosmetic Act of 1958, ionizing radiation was defined as a food additive. Accordingly, it must be shown to be safe for its intended use before it can be certified. (Bernarde, 8) Extensive testing has been undertaken to learn the effects of radiation on food wholesomeness. This testing program consists of five parts. The first part is a two-year animal feeding study to determine if long-term consumption could result in a chronic toxicity. Secondly, comparative studies between heat and radiation-processed foods are being conducted to determine the effect radiation has on nutrients. A carcinogenicity experiment is being performed to see if consumption of radiation-processed food will produce tumors in animals. Fourthly, blood and tissue enzyme research is being conducted to see if the experimental animal's metabolism is altered. Finally, histopathological studies are being made on post-mortem tissues of experimental animals that have been fed irradiated food for a long period of time. (Urrows, 65) If a radiation-processed food passes all these tests, then the FDA will be petitioned to certify it. If the product is a meat product, both the FDA and the Meat Inspection Division of USDA must approve it. (Urrows, 65)

In 1966, the FDA cautiously certified irradiated canned bacon, white potatoes, wheat, and wheat flour as safe for human consumption. However, in 1968, they rescinded certification for bacon to await results of new feeding tests. White potatoes are still irradiated to inhibit sprouting. Wheat and wheat products are irradiated to eliminate insects and their eggs. At the present time these are the only instances in which the FDA permits food irradiation. But the USSR, which is usually very conservative in its approval of food additives, allows unrestricted use of irradiated fresh fruit and vegetables, dried fruit, grain, and potatoes. The Atomic Energy Authority of the United Kingdom reported in March, 1970, that the Authority had developed techniques for bombarding fish and that it had imported frozen meat pet foods with controlled doses of cobalt rays. Such irradiated foods had been fed to animals for six years with no ill effects (Bernarde, 8) Israel allows the sale of irradiated potatoes and onions; the Dutch allow irradiated mushrooms. In 1970, over 50 nations had scientific and technical staffs hard at work developing radiation preservation methods for foods. (Pizer, 66)

The organoleptic problems--alterations in color, taste, and odor--which plagued early radiation processing attempts have been solved, for the most part, by recent research. (Urrows, 65) Meats, especially, suffered alteration in odor, flavor, texture and color. Research found that these are eliminated or substantially reduced by irradiating at very low temperatures, by applying absorbents as odor scavengers, by using spices and condiments skillfully, and by adopting appropriate cooking practices. For example, if meat is irradiated at -32 to -78 F, off-flavors are markedly reduced. Further, chicken that has been precooked and then irradiated at -78 F has little if any detectable irradiated flavor. Off-flavors and odors of irradiated beef have also been virtually eliminated.

Research is still continuing into ways to combine irradiation with other methods, like heat, to produce an acceptable product. One such study with shrimp reported that "preservation processes based on combination of heat treatment and low-dose irradiation result in shelf-stable products for inland consumption which can be transported over long distances without refrigeration... The heat-radiation combination process with its likeliness to aseptic canning used for liquids and semisolids adds a new dimension to the preservation of fresh foods." (Savagnon et al., 67) Another group of authors recommends the combination of dehydration and irradiation for shrimp and other foods. However, optimum conditions need to be established for each individual process. (Gore et al., 68)

Researchers also find that irradiation increases the rate of freeze drying, although not sufficiently to warrant its use in commercial freeze drying unless very thick samples are used. (Hatcher and Sunderland, 69)

In conclusion, to be commercially successful, a radiation preservation method ultimately must produce products which are not only wholesome and acceptable but ones which can compete with other foods.

A writer for the AEC suggests that by 1980 a number of irradiated foods will appear on the supermarket shelf. Although he doesn't feel that irradiation will dominate the food industry, he does think that it will become the preferred way to preserve a number of foods because it will offer advantages that other methods to not have. Fish, because it is highly perishable, could benefit from low-dose radiation. Radiation-pasteurization of shucked soft-shelled clams, haddock, flounder, crabs, and shrimp is feasible and would be advantageous to both industry and consumer, since it would lengthen refrigeration storage time and broaden the market for unfrozen fish. The housewife would no longer have to prepare the fresh fish she bought at the store that day for the same day's dinner. Radiation-pasteurization also promises to keep fruit, especially oranges, cherries, and peaches, edible longer. (Urrows, 65)

Although reappertization will probably not be applied immediately to commercial foods that spoil easily and are shipped in large quantities, it does have potential for special military projects and institutional use.(Pizer, 66)

Protein Supplements

A recent report of the USDA has indicated that contrary to previous speculation, food shortages by 1980 are not expected since new materials and techniques are constantly being developed to increase our food supply. Improvement in production, processing, and marketing have supplied the U.S. food needs to date, but we have increasingly turned to substitute products. The search for substitutes is expanding as knowledge of new breeds of plants and animals and different processing techniques increases. Raw materials now also come from nonagricultural sources, such as coal or petroleum, as well as from plants and animals. These substitutes are being developed due to pressure for lower cost, greater utility, and convenience.(Gallimore, 70)

Total sales of fabricated food products were almost $13 billion in 1972 and are expected to exceed $23 billion (or 7.8 percent of all food sales) by 1980. In this eight-year period, meat shortages and rising prices will accelerate interest in vegetable protein products as substitutes for meat. Sale of these substitutes are expected in the words of Trauverman (72) "to explode to $1 1/2 billion by 1980." (See Table 4.)

The purpose of this section is to give an up-to-date description of the technology concerned with producing new sources of protein. Because this subject is so vast, references to reviews will be given for those who wish to read further. The protein sources that will be dealt with include soybeans, other plants, single cell protein, fish protein concentrate, and whey proteins.

Vegetable Proteins

Until the early seventies, the meat market was not threatened by substitutes because of strong consumer loyalty and taste preferences. How, however, the technology of fabricating foods from vegetable proteins has improved so much that substitutes for meat command attention. Also, the adverse publicity concerning the use of animal fat in the diet has caused more people to consider plant sources. Finally the lower cost of vegetable proteins makes them attractive for programs designed to upgrade the diets of low-income people in the U.S. and abroad. Vegetable proteins are prepared for two general purposes: (1) as partial or complete substitutes for meat in a processed item or (2) as meat analogs that resemble meats in texture, color, and flavor.

Protein ingredients are sometimes added to processed food products primarily to improve their physical properties, rather than their nutritional properties. Soy, for example, is added to baked goods to retain water, to whipped dairy products to stabilize the product, and to non-fat dry milk for specific functional characteristics. Various vegetable protein ingredients are used in processed meats to bind particles together and to retain natural juices. When a processor has a choice of proteins with functionally similar characteristics, cost is usually the determining factor. Two prospective changes in the 1970's are (1) a larger proportion of protein will be produced for human consumption from plant sources, such as oilseeds, legumes, and grains; and (2) more proteins will be consumed as ingredients in fabricated foods. (Gallimore, 70)

Soy. A bushel basket of soy beans contains 11 pounds of soy oil and 47 pounds of 44 percent protein meal. The defatted soy protein is supplied in four major types, flour and grits, concentrates, isolates, and textured items. All come from clean, dehulled soybeans, but they differ in protein content, physical and chemical properties, food application, and price. (See Table 5.) Flour and grits are the simplest forms and the lowest in protein. They are used for baked goods and canned meats, for example. Concentrates are from 60 to 70 percent crude protein and isolates are from 90 to 97 percent crude protein. These two are higher priced than flour and grits due to the additional processing costs and lower yields on the finished products. Textured products are made from all three and are the most expensive. In 1970, 17 firms were producing soy proteins for human consumption. Meat analogs have been marketed for some time, primarily for those who cannot or prefer not to eat meat. Recently, more firms are expanding and promoting these analogs, some of which are priced competitively with meat in a cost per portion served after cooking, making them important in institutional food service.

The textured protein products are formed by two main processes--extrusion and spinning. The thermoplastic extrusion process uses a 50 percent protein content soy flour as the starting material. The flour is cooked and then extruded through a die which controls its size and shape. Dry, the textured material costs 27 to 45¢ per pound, but after hydration this becomes 9 to 15¢ per pound meat replacement. In the spinning process, isolated soy protein is dissolved in an alkaline medium and passed through a spinneret to form fibers which are then coagulated in an acidic bath. The coagulated fibers are then stretched by a series of rollers revolving at increasing speeds. The bundles of fibers are held together with edible binders and treated with other ingredients such as colors, flavors, seasonings, and supplementary nutrients to produce slices, cubes, bits or granules which may simulate beef, bacon, ham, chicken or other meats. The price of these products per pound ranges from 50 to 80¢ on approximately a 60-percent moisture basis. (Horan and Burket, 73)

As of 1971, products made by the spinning process are finding greater acceptance as meat replacements, whereas the thermoplastic extruded products are mostly used in combination with meat. (Horan and Burket, 73)

Other plant proteins. Soy, although the most popular plant protein, is not the only one on the market. Cottonseed protein has recently become commercially available as a 65-percent protein flour, and isolates of this protein should be on sale in the near future. Peanut flour, with about 57-percent protein, could be another source of high quality protein concentrate, and successful oat and corn protein concentrates have been made by U.S.D.A. researchers. Concentrates from sunflower seeds, coconuts, and ropeseed have also been successfully produced by scientists in other parts of the world.

One example of a low-cost, high-protein, grain-based food product to be used for mass consumption in both developed and developing countries is Golden Elbow Macaroni. Made of corn, wheat, and soy flours, it has been approved as a 50-percent replacement for meat or meat alternates in a Class A Lunch. A typical serving of one ounce of ground beef and one cup of cooked golden elbows costs 8¢ while 2 ounces of ground beef and one cup of regular macaroni costs 14¢ and is not as nutritious. This illustrates what can be gained by using cereal grains as a base for acceptable, high-protein food products with reasonable low cost.

The Future of Textured Plant Proteins

In 1972, a U.S.D.A. publication noted that labeling regulations, standards of identity, and tastes are factors that might limit meat analog expansion in the next five to ten years. (Gallimore, 70) Despite these obstacles, as protein supply dwindles relative to population, the use of textured protein products is expected to increase in order to augment, supplement, and extend our existing protein sources. A Cornell Study forecasted that meat extenders and analogs from formulated protein sources may reach 10 percent of all domestic meat consumption by 1985, certainly by 2000. This growth would increase protein ingredients used in the meat industry from 145 million pounds per year to 2.45 billion pounds per year by 1985--an annual growth rate of 19.3 percent. The food industry believes that vegetable proteins--and textured vegetable proteins in particular--will enjoy a healthy portion of this market. (Lockmiller, 75)

Although work is continuing to improve the flavor and texture of vegetable proteins, they already have certain advantages because they are noncellular. For example, they can be frozen and thawed many times with little change in texture, flavor, or appearance, and they may be cooked without breaking down readily. Also, they have a storage life of about twice their natural meat counterpart because they are manufactured sterilely and contain no enzymes which would cause deterioration. (Robinson, 76)

Institutions, including hospitals, schools, and organizations that must produce nutritious meals under budget restraints, will probably provide the first major market for extender-type soy proteins. Controlled therapeutic diets could use these foods, which also provide a means of nutritionally standardizing experimental diets for research. Usually, extender foods must be fortified with vitamins found in the natural products that they simulate. Other nutrients can be added so that the final product can be even superior to the natural product. Meat analogs which contain less fat than most animal products, are also good for those on fat restricted diets. (Robinson, 76)

The greatest hinderance to the acceptance of textured plant protein is lack of education. Any product suspected of being a substitute product must offer a definite economic advantage in order to overcome the substitute stigma. Thus, the marketing of consumer products made from vegetable protein got a new impetus in 1973 as consumers became economy-minded regarding protein. Since the meat shortage and the rise in food prices, more and more consumers have turned to protein extenders and substitutes to provide low cost nutritious meals for their families. Although previously only bacon flavored chips had achieved commercial success, ten food companies have introduced new protein substitutes. (Anonymous, 77) These products include protein granules with and without fibers; special red meat extenders with fibers; special extenders for crabcakes, fishcakes, and other seafoods; poultry extenders; and meat analogs (ham, chicken, turkey, beef, and corned

Table 4. Current and Estimated Fabricated Food Markets (1972-1980)

	1972	1976	1980
	(millions of $)		
Dairy substitutes	847.4	994.2	2527.4
Beverages	157.3	211.8	273.9
Snack foods	2001.8	2467.3	3066.1
Prepared desserts	60.0	82.0	111.0
Salad dressings			
spoonable	313.6	370.9	429.2
pourable	122.6	172.0	238.1
Vegetable protein products	82.0	316.5	1531.9
Dietetic foods	39.5	47.7	96.0
Prepared cereals	670.0	753.0	848.0
Cookies and crackers	1558.0	1686.0	1825.0
Cake and roll mixes	230.5	240.6	250.4
Pop tart products	68	86	109.0
Soft drinks	5450.0	7412.0	10100.0
Pet foods	1304.0	1648.0	2081.0
	12904.4	15588.0	23497.0

Source: Food Technology, 1973

Table 5. Soy Protein Foods

Soy Protein Food	Protein Content	Price	Estimated 1970 Production in U.S.	Current Uses
	%	6/lb.	million lb.	
Flour and grits*	30 - 55	5 1/2 - 11 1/2	325 - 500	ingredients for baked goods, dog foods, sausages
Concentrates	60 - 70	18 - 25	25 - 30	manufacturing of textured products; ingredient in processed meats, baby foods, health foods
Isolates	90 - 95	35 - 45	20 - 25	manufacturing of analogs. For use in comminuted meats such as meat loaf, frankfurters, etc.
Textured items**				
Extruded	50 - 55	28 and up	25	bacon strips and bits; pork; beef; chicken; fish; ham; and similar foods

*Flour and grits, although handled differently and sold for different uses, are essentially the same product. Both are ground defatted flakes. Grits are coarse ground (larger than 100 mesh0: flour is fine ground (Smaller than 100 mesh).

**Textured items are of two distinctly different types. Extruded items, made from flour, are textured by high-temperature, high-pressure extrusion, using a plastic type extruder. Spun items, made from isolates are made by somewhat the same techrique used for rayon or nylon.

Source: JADA 58: 104, February 1971)

beef) made entirely of plant proteins to be used with or without real meat in casseroles, dehydrated products, canned spreads, canned soups, and other convenience foods. (Robinson, 76)

Several uses of soy beans other than as extenders or analogs, have been suggested. These include Tempet, a fermented soy food from the orient; sufu, a soy bean cheese; and wheat-soy blend (WSB), a U.S.D.A. designed flour. (Bird, 10) Still another researcher advocates soybeans as a deep-fried snack food. (Collins and Sanders, 78)

It is hoped that a great number of students, who now eat these products in their meat patties, chili, hot dogs and casseroles, as part of the school lunch program, will become the dedicated users of plant protein products five years from now. In any case, by 1980, textured plant protein extender will probably displace a significant quantity of meat in meat-type foods in the institutional market, though retail markets are expected to be slower to develop.

Single Cell Protein

Single cell protein is a generic term for either crude or refined sources of protein derived from unicellular or simple multicellular organisms, such as bacteria, yeast, algae, and fungi. Presently, these sources are being developed for animal feed but ultimately they will be used as human food.

However, there are three basic problem areas that must be considered in assessing the potential of algae, bacteria, and yeast for food or feed. First, there are the problems associated with the organism itself--genetic stability, growth rate, and yields on substrates of economic interest. Second, there are the problems associated with production cost and availability of subtrates, heat out, cooling costs, maintenance of sterility, measures to avoid contamination of the finished product by pathogenic organisms, harvesting and associated costs, and costs of drying. Finally there are the problems associated with the product--presence of endotoxin and pathogenic organisms, protein content, fat content, amino acid profile, protein digestibility, biological values, acceptability from flavor, aroma, color and texture standpoints, market development, and marketing costs.

Algae falls short in several of the above areas. It is characterized by poor digestibility, marginal biological value in some species, undesirable aromas and flavors, poor resistance against enteric pathogens, and difficult and costly harvesting. Considering all these drawbacks, it seems unlikely that algae will become a significant commercial source of protein for food or feed in the foreseeable future. (Lipinsky and Litchfield, 79)

Yeast, on the other hand, has had feed and food uses for many years. (Lipinsky and Litchfield, 79) It is an excellent source of high quality 55-60 percent (dry basis) protein and B vitamins. Technology has developed a way to produce yeast from petroleum. The n-paraffin fraction in particular is already well-developed. (Trauverman, 72) However, problems still exist with regard to substrate cost and availability, processing costs associated with maintaining sterility, cooking, harvesting, and marketing the product at prices competitive with existing plant and animal proteins. (Lipinsky and

Litchfield, 79)

Bacteria only recently have been considered as protein sources. Their rapid growth rate and high protein content with favorable amino acid profiles are definite advantages. However, the possible presence of endotoxin in the cells, genetic transformation through mating, processing costs associated with maintaining sterility, cooling, harvesting, and the establishing of wholesomeness and safety to the satisfaction of regulatory agencies are all drawbacks. (Lipinsky and Litchfield, 79)

It is likely that microbial protein will find a place in food and feed markets of the future as a supplement to existing products or as a source of protein for fabricated foods. Its low cost, wide availability, and high nutritional value, will promote acceptance, but there will be many technical difficulties, including product safety and the conservative position of consumers toward new food products. (Lipinsky and Litchfield, 79) Because it is not enough to produce just a good source of protein (the product must also be "acceptable" to the consumer), the future of these forms of single cell protein depend upon the ingenuity of the food technologist.

A recent review of the uses of fungi summarizes its possible contribution to the protein market.

> While much research yet remains to be done, methods are now available by which almost unlimited quantities of protein can be produced by culturing funal mycelia submerged in liquid media with a cheap or waste carbohydrate (carbon source) and an inorganic nitrogen salt (nitrogen source). We may find that in the not too distant future, it may be necessary to run separate lines from kitchen garbage disposal units to fungal, yeast or bacterial processing plants where microbial protein can be made and at the same time, prevent sewage disposal plants from being

> overloaded. Processes like these will increase the absolute amount of protein and also provide means of producing protein from materials which are now allowed to go to waste. In terms of cost per pound, it is improbable that at this stage fungal protein could be produced in many areas at a cost which would enable it to be competitive with soybean protein.
>
> Exactly when fungi and other microbes of potential will be exploited fully as sources of protein cannot be predicted. At this time the fungi must be considered one of man's few remaining relatively unexploited food resources. (Karnes, 45)

Fish Protein Concentrate

Most of the aquatic proteins are consumed in forms in which the raw material retains its identity. New processes and products that will permit and increase the use of aquatic protein primarily as a protein supplement are being developed in widely different places and for widely different purposes. In these processes, the raw material usually loses its identity. This broadens the possibility of usefulness and dissemination. Although researchers are attempting to find better ways to preserve "fresh" fish as it is because of consumer preference, most scientists now feel that an economical and efficient use of aquatic protein can only be achieved when raw material identity is lost. (Parisen, 81) Fish Protein Concentrate (FPC) is one of these new products.

FPC is any product made from fish in which the protein is more concentrated than in the original raw material. The end product may assume a variety of forms. There is no one FPC, but instead a family of products. Presently, the term FPC is generally restricted to a solvent-extracted product, high in nutritive value but not very versatile. This particular one is covered by the FDA definition of whole protein concentrate, as that which is derived from whole, wholesome lake and lakelike species of fish handled expeditiously and under sanitary conditions in accordance with good manufacturing practices recognized as proper for fish that are used in other forms of human food. The additive consists essentially of a dried fish protein processed from the whole fish without removal of head, fins, tail, viscera, or intestinal contents.

For nearly a quarter of a century, politics delayed the introduction of FPC in any significant quantity in the United States. Both product and process are still accepted here only with reservation. Because the FDA designated FPC as a direct food additive, it is subject to controls covering all food additives. Furthermore, the FDA has specified that this product is for use only in homes and it may not be sold in packages weighing more than 1 pound. This prevents FPC from being used in food products on a commercial scale. In Canada, it can be packaged in bulk and used in manufactured foods. (Bernarde, 8)

Yet three companies have powdered FPC products ready for the market. They include Cardinal Proteins LTD in Nova Scotia, Alpine Marine Protein Industry, Inc., in Massachusetts, and the Astia Company of Sweden. Alpine's Product, "Instant Protein," comes in half-ounce packets that are designed to be blended with a cup of flour. The company claims its product can also be blended into mashed yams and potatoes, corn fritters, potato pancakes, and spaghetti sauce. (Bernarde, 8) An experimental demonstration plant was built with federal funds in Aberdeern, Washington. It was designed to process seven to eight tons of FPC per day. The product is being used for experimental purposes. (Parisen, 81)

At the present time, too little is known to make sound predictions as to the success of various forms of FPC. However, all the protein additives (soy concentrate, cottonseed concentrate, skim milk, FPC, and dried fish) at their present state of development can be useful protein supplements at similar order of cost, and therefore none that fall within reasonable range should be ruled out for further exploration or development. FPC at 28.8 to 53.8¢ per pound of protein could compete in the expanding U.S. market which requires protein ingredients for beverages, breakfast foods, canned meats, processed meats, and even baked goods. Its best hope lies in competition with soy isolates for use in baby foods, baked goods, and processed meats. Success in higher priced fields would depend upon FPC's possessing a neutral flavor and suitable functional properties. (Finch, 82)

Whey as a Protein Source

The final protein source that will be discussed is whey. For many years, cheese makers just dumped their whey in a stream. Discarding the whey was not only a great loss of food (3/4 of milk's nutritional value), but also a major source of water pollution. Now whey is recovered by reverse osmosis (also known as membrane ultrafiltration) before it becomes waste. Ultrafiltration avoids many of the deleterious effects of normal dehydration. It can remove up to 90 percent of the water while avoiding thermal and oxidative degradation of the product. Vermont cheese makers now recover $1.4 million worth of whey. This recovered whey protein can be used in bread, processed cheese, sherbert, candy, and many other products. When mixed with skimmed milk, it can be used as an infant formula. Although reverse osmosis can concentrate the solids, it cannot dry the product. However, this concentration greatly reduces the load on spray dryers. (Porter and Michaels, 83)

It is believed that whey protein can be marketed as a high protein food supplement for about 25¢ per pound. Furthermore, it is estimated that this reclaimed protein could enrich the protein diets of 20 million people. (Porter and Michaels, 83)

Applications of Microwave Energy

Any substance containing free polar molecules is affected by microwave energy. Water is polar and it is distributed fairly uniformly in foods. Therefore, it is possible to heat foods with microwave energy. When a food is subjected to microwave energy the randomly-oriented water molecules align themselves with the electromagnetic field. Microwaves are a rapidly changing electromagnetic field in which the polar molecules rotate around their axis millions of times per secnd and thereby create friction which results in heat. (Tape, 84)

In 1964, practical continuous microwave ovens with high powered generating tubes were made available to the food industry, and with industrial scale food processing applications in sight, interest in microwave energy mounted. Thus far, perhaps the two most successful uses of microwaves have been finish-drying potato chips and cooking chickens. The most important factor in potato chip sales is color, with the light colored chip being preferred. The color is the result of nonenzymatic browning between amino acids and reducing sugars. Frying in hot fat with hot air or infra-red drying accelerates browning. Microwave drying allows the use of a high content reducing sugar potato. The chip processed with microwave energy and hot air also has a longer shelf-life than the finish-fried chip. (Decareu, 85) In 1965, there were 24 finish-dryers using microwaves for potato chips. By 1975, the estimate is that 127 dryers will be in use. (Tape, 84)

As for chicken, the largest single industrial installation cooks 20,000 pounds of it in eight hours using a combination of steam and microwaves. The chicken is breaded after cooking, frozen, and packaged for distribution. (Hall, 34)

Other commercial uses of the microwave include two processes for producing donuts (Schiffman _et_ _al_., 86); the preparation of pasta for dry soup mixes (Maurer _et_ _al_., 87); and the continuous baking of bread utilizing microwave energy to replace the conventional thermal baking process (Anonymous, 88). The advantages of these methods over conventional processes include, to name a few, reduced costs, better product quality, and savings in equipment space and processing time. Microwaves have also been used successfully to open oysters. This again decreases man power requirements, as well as the need for skilled labor. (Decareau, 85)

With microwave processing currently "in the spotlight," everyone is wondering whether his product can be produced faster or cheaper. The number of potential applications is almost limitless and one is tempted to try every process and pass every suggested product through whatever equipment is at hand. However, one cannot buy a piece of microwave hardware off the shelf, start putting the product through it, and expect to achieve commercial success. Each product appears to require its own special application to achieve optimum results. It is necessary to couple food and microwave technology, with a reasonable quantity of cash, in order to achieve successful drying, cooking, blanching and thawing of food with microwaves. (Tape, 84)

Considerable microwave research has attempted to determine whether this form of energy can reconstitute and heat food products. As a result, second generation microwave ovens with sophisticated controls are now available. Litton even has a commercial microwave oven which features an automatic defroster in addition to its regular oven capacities. The applications of microwave ovens in all types of food service operations present new and interesting challenges to both the food processor and the microwave oven manufacturer. Litton now offers the services of its "food team" to food processing companies in order to develop effective applications for microwave ovens. (Daly, 89)

The use of microwaves for heating meals has greatly increased in all types of institutions. Hospitals are particularly interested in these new methods. The program consists of the cold assembly of patient trays using pre-prepared foods followed by "on demand" microwave heating of meals within patient areas. These methods have been found to increase menu variations and reduce waste. Late meals no longer present a problem to the over 200 hospitals using this plan. (Anonymous, 90)

Still pure microwave processes are the exception and not the rule. In many instances, all microwave processes cannot produce a satisfactory product. The potential processes of baking, blanching and sterilization would all involve an auxiliary heat source. But more importantly, imagination and effective teamwork between the food and microwave technologist are the essential ingredients for success--the more efficient production of better quality food. (Tape, 84)

Food Processing Methods

A Bibliography

1. Anonymous. "New aseptic process used for canning fruits and vegetables." *School Food Service Journal* (September, 1973), p. 15.

2. Anonymous. "Bulk handling of fruits and tomatoes." *Food Processing* 34(1) (January, 1973), pp. 24-25.

3. Anonymous. "Developments to watch." *Food Engineering* 45(6) (June, 1973), p. 21.

4. Anonymous. "Ultra high temperatures." *Agricultural Engineering* 52(5) (May, 1971), pp. 264-265.

5. Anonymous. "To foam dry O.J." *Food Engineering* 40(2) (February, 1968), p. 158.

6. J. Angione. "Racing toward a $10 billion market." *Quick Frozen Foods* 35(5) (December, 1973), p. 21.

7. L. G. Bartolome, J. E. Hoff, and K. R. Purdy. "Effect of resonant acoustic vibrations on drying rates of potato-cylinders." *Food Technology* 23 (March, 1969), p. 231.

8. Melvin A. Bernarde. *The Chemicals We Eat*. (New York: American Heritage Press, 1971), pp. 61-63, 95, 99, 1650180.

9. R. F. Berry. *et al.* "Preparation of instant orange juice by foam-mat drying." *Journal of Food Science* 37 (1972), pp. 803-808.

10. Kermit Bird. "The food processing front of the seventies." *J.A.D.A.* 58 (February, 1971), pp. 103-108.

11. Kermit Bird. "The freeze-drying industry: projections of capital and labor requirements." *USDA-ERS, 1963-1970* (April, 1964).

12. Kermit Bird. "Freezing-drying attitudes." *USDA-ERS* (1965).

13. Kermit Bird. "Palatability of freeze-dried meats." *Food Technology* 19 (May, 1965), pp. 737-739.

14. S. J. Bishov, *et al.* "Quality and stability of some freeze-dried foods in zero oxygen headspace." *Journal of Food Science* 36 (1971), p. 532.

15. George Borgstrom. Principles of Food Science (London: The MacMillan Co., 1969), pp. 273-288, 326-331.

16. A. L. Brody. "Food product packaging and marketing." Food Technology 27(9) (September, 1973), pp. 41-44.

17. A. L. Brody. "Aseptic packaging of foods." Food Technology 26 (August, 1972), pp. 70-74.

18. A. L. Brody. "Updates aseptic packaging - part 1." Food Engineering 45(2) (February, 1973), pp. 96-112.

19. C. H. Brown, D. F. Farkas, and E. D. De Marchena. "Centrifugal fluidized bed." Food Technology 26 (12) (December, 1972), pp. 23-24,26,28,30.

20. Maxwell C. Brockman. "Development of IMF for military use." Food Technology 24 (August, 1970), pp. 896-900.

21. S. B. Bucholz, and G. M. Pigham. "Immersion freezing of fish in dichloro difluromethan." Journal of Food Science 37 (1972), pp. 416-420.

22. K. C. Chen, B. S. Lah, and M. E. Schafer. "Chemical changes in strained peas canned by the aseptic and retort processes." Food Technology 24 (July, 1970), pp. 820-826.

23. R. B. Davis, F. E. Long, and W. F. Robertson. "Engineering considerations in retort processing of flexible packages." Food Technology 26(8) (August, 1972), pp. 65-68.

24. P. W. deRoyter and R. Brumet. "Estimation of process conditions for continuous sterilization of foods containing particulates." Food Technology 27(7) (July, 1973), pp. 44-51.

25. Norman W. Desrosier. The Technology of Food Preservation, 3rd ed. (Westport, Connecticut: AVI Publishing Co., 1970), pp. 270-309.

26. Diane Farmakis. "Cryogenic freezing comes of age." Quick Frozen Foods 35(8) (March, 1973), pp. 44-46.

27. Tom Finnegan. "Frozen foods in food service." Quick Frozen Foods 35(8) (March, 1973), pp. 44-46.

28. Y. H. Foda, M. G. E. Hamerd, and M. A. Adb-Allah. "Preservation of orange and guave juices by freeze-drying." Food Technology 24 (December, 1970), pp. 1392-1395.

29. B. A. Fox and A. G. Camero. Food Science, A Chemical Approach (London: University of London Press Ltd, 1970).

30. Thomas E. Fuman, ed. *CRC Handbook of Food Additives* (Chemical Rubber Co Publishing Co., 1968), pp. 138-140, 209, 225, 271-272, 306.

31. S. A. Goldblith "The science and technology of thermal processing." *Food Technology* 26 (January, 1972), pp. 64-69.

32. S. A. Goldblith and M. Karel. "Stability of freeze-dried foods," in L. Rey, ed. *Advances in Freeze Drying* (1966), pp. 191-199.

33. W. S. Greig. *The Economics of Food Processing* (AVI Publishing Co., 1971).

34. W. A. Hall. "The special insight: The distributor's view of the advancement of frozen food systems." *Food Service Marketing* 35(4) (April, 1973), pp. 56, 58, 60, 62.

35. G. R. Havighorst. "System cuts cost of aseptic packaging." *Food Engineering* 45(3) (March, 1973), p. 74.

36. D. A. Heatherbell, *et al.* "Carrot volatiles 1. Characteristics and effects of canning and freeze-drying." *Journal of Food Science* 36 (1971), pp. 223-224.

37. J. I. Hendrick. "Aseptic packaging in paperboard containers." *Food Technology* 27(9) (September, 1973), pp. 46-47.

38. D. E. Henke, "Aseptic packaging cuts returns." Food Engineering 45(3) (March, 1973), pp. 93-95.

39. D. A. Herbert. "Canning." *Nutrition and Food Science* 24 (July, 1971), pp. 18-20.

40. A. L. Brody. "Food canning in rigid and flexible packages." *CRC Critical Reviews in Food Technology* 2(2) (July, 1971), pp. 187-243.

41. Martin S. Hertzendorg and Raymond J. Moshy. "Foam-drying in the food industry." *CRC Critical Reviews in Food Technology* 1(1) (June, 1971), p. 25.

42. R. Hoeft, R. P. Bates and E. M. Ahmed. "Cryogenic freezing of tomato slices." *Journal of Food Science* 38 (1973), p. 38.

43. S. D. Holdsworth, "Dehydration of food products, a review." *Journal of Food Technology* 6(4) (1971), pp. 331-370.

44. M. Karel. "Recent research and development in the field of low-moisture and intermediate-moisture foods." *CRC Critical Reviews in Food Technology* 3(3) (February, 1973), pp. 329-373.

45. W. G. Karnes. "Trends of tomorrow in the food industry." Research Development Assoc. Act. Report 24(2) (1972), pp. 24-36.

46. Arnie Katz, "State of the industry." Quick Frozen Foods 35(5) (December, 1973), pp. 24-26, 28, 30, 32.

47. Judson C. King. "Freeze-drying of food-stuffs." CRC Critical Reviews in Food Technology 1(3) (1970), pp. 379-451.

48. M. E. Lazar and D. F. Farkas. "The CFB 2. Drying studies on piece form food." Journal of Food Science 36 (March, 1971), p. 315.

49. M. E. Lazar and J. C. Miers. "Improved drum-dried tomato flakes." Food Technology 25 (August, 1971), pp. 830-832.

50. A. P. Longmore "Advances in vacuum and freeze drying." Food Processing Industry. 40 (476) (June, 1971), pp. 46-49.

51. J. Lu and W. E. Townsend. "Feasibility of adding freeze-dried meat in the preparation of fermented dry sausage." Journal of Food Science 38 (1973), pp. 837-840.

52. B. S. Luh, John Antonakos, and H. N. Daoud. "Chemical and quality changes in strained carrots canned by the aseptic and retort processes." Food Technology 23 (March, 1969), pp. 377-381.

53. C. W. Lyne. "A review of spray drying." British Chemical Engineering 16 (4/5) (April, May, 1971), pp. 370-373.

54. G. J. Malecki, P. Shinde, A. I. Morgan Jr., and D. Farkas. "Atmospheric fluidized bed freeze drying." Food Technology 24 (May, 1970), p. 603.

55. James H. Moy. "Vacuum-puff-freeze-drying of tropical fruit juices." Journal of Food Science (1971), pp. 906-910.

56. C. L. Rasmussen and R. L. Olsen. "Freezing methods as related to cost and quality." Food Technology 26 (12) (December, 1972), pp. 32, 34, 36-38, 41, 44, 47.

57. L. Rey. "Recent developments in freeze-drying and cryogenics." Nestle Research News (1972), pp. 48-53.

58. D. K., Salunkhe, J. Y. Do, and H. R. Bolin. "Developments in technology and nutritive value of dehydrated fruits, vegetables and their products." CRC Critical Reviews in Food Technology 4(2) (1973), pp. 156-188.

59. H. I. Sinnamon, N. C. Aceto, and E. F. Shoppet. "The development of vacuum foam-dried whole milk." Food Technology 25 (1971) pp. 1264-1276.

60. W. R. Smithies. "Freeze-drying of meat and meat products," in L. Rey, ed. *Advances in Freeze-drying* (1966), pp. 177-187).

61. Arnold Spicer. "Freeze-drying of foods in Europe." *Food Technology* 23 (October, 1969), p. 1272.

62. G. F. Steward and M. A. Amerine. *Introduction to Food Science and Technology* (New York and London: Academic Press, 1973), pp. 191-199.

63. R. T. Toledo and J. R. Chopman. "Aseptic packaging in rigid plastic containers." *Food Technology* 27 (11) (November, 1973), pp. 68, 76.

64. E. R. Wolford and J. W. Nelson. "Comparison of texture of carrots frozen by airblast, food freezant-12, and nitrogen vapor." *Journal of Food Science* 36 (1971), pp. 959-961.

65. G. M. Urrows. *Food Preservation by Irradiation* (Oak Ridge, Tennessee: U. S. Atomic Energy Commission-Division of Technical Information, 1964).

66. Vernon Pizer. *Preserving Food with Atomic Energy*. (United States Atomic Energy Commission, 1970)

67. K. A. Savagnon, *et al.* "Radiation preservation of shrimp T. for ambient temperature storage." *Journal of Food Science* 37 (1972), pp. 147-150.

68. M. S. Gore, P. L. Sawant, U. S. Kumba, and A. Screenivasan. "Dehydro-irradiation process for tropical shrimp." *Food Technology* 24 (October, 1970), p. 1167.

69. J. D. Hatcher and J. E. Sunderland. "The effect of gamma radiation on freeze-drying rates." *Journal of Food Science* 37 (1972), p. 336.

70. W. W. Gallimore. "Synthetics and substitutes for agricultural products: projections for 1980." *Marketing Research Report No. 947*. (March, 1972).

71. Anonymous. "Fabricated food market to excede $23 billion by 1980." *Food Technology* 27 (12) (1973), p. 40.

72. L. Trauverman. "Planning ahead for low cost protein." *Food Engineering* 46(1) (January, 1974), pp. 70-72.

73. F. E. Horan and R. E. Burket. "Engineered foods--the place for oilseed proteins." *Food Technology* 25 (August, 1971), pp. 813-818.

74. A. S. Claus, "Cereal grains as dietary protein sources." *Food Technology* 25 (August, 1971), pp. 821-825.

75. N. R. Lockmiller. "What are textured products?" Food Technology 26(5) (May, 1972), pp. 56-58.

76. R. F. Robinson. "What is the future of textured protein products?" Food Technology 26(5) (May, 1972), pp. 59-63.

77. Anonymous. "New food--vegetable protein products intros increase in 1973." Food Engineering. 46(2) (February, 1974), pp. 49-50.

78. J. L. Collins and G. S. Sanders. "Deep-fried snack food prepared from soybeans and onions." Food Technology 27(5) (November, 1972), pp. 46, 50, 52, and 54.

79. E. S. Lipinsky and J. H. Litchfield. "Algae, bacteria and yeasts as food or feed." CRC Critical Review in Food Technology 1(4) (1970), pp. 581-615.

80. Steven R. Tannenbaum. "Single cell protein--food of the future." Food Technology 25 (September, 1971), pp. 962-967.

81. E. R. Parisen. "Proteins of aquatic origins." Food Technology 25 (November, 1971), pp. 88-100.

82. Roland Finch. "Fish protein for human foods." CRC Critical Reviews in Food Technology 1(4) (1970), pp. 519-580.

83. M. C. Porter and A. S. Michaels. "Food applications for membrane ultrafiltration." Food Product Development. 60 (March, 1971) pp. 66-67.

84. N. W. Tape. "Application of microwave energy in food manufacture.' Canning Institute Food Technology Journal 3(2) (1970), pp. 39-43.

85. R. V. Decareau. "Microwave energy in food processing application." CRC Critical Reviews in Food Technology 1(2) (1970), pp. 199-224.

86. R. F. Schiffman, et al. "Applications of microwave energy to doughnut production." Food Technology 25 (July, 1971), pp. 718-722.

87. R. L. Maurer, et al. "Microwave processing of paste." Food Technology 25 (1971), pp. 1244-1249.

88. Anonymous. "Hope of new breakthrough in bread technology." Food Manufacture 46(7) (1971), pp. 46-47.

89. P. N. Daly, "Microwave compatible food service products." Food Technology 25 (September, 1971), pp. 918-921.

90. Anonymous. "Microwave heating system in over 200 hospitals." Food Processing 33(September, 1972), p. 14.

NUTRITION AS IT AFFECTS
AND WILL AFFECT FOOD SERVICE

by

Barbara Shannon, Ph.D.

and

Colleen Patterson Greecher

NUTRITION AS IT AFFECTS
AND WILL AFFECT FOOD SERVICE

An Introductory Review of the Literature

The authors undertook a review of representative food service industry magazines and journals to assess the current status of nutrition as a science and practice in the industry. The review covered the years 1968 and 1973. Articles in the trade literature dealing with nutrition were categorized into five major areas depending on the aspect of nutrition with which they dealt.

Current and Projected Trends which have Nutritional Implications

Current trends. Consumers have grown more "nutrition conscious" according to Wallace (169, 171) and therefore, the food service industry may experience a greater need for the professional services of dietitians, nutritionists, and home economists in the future. Aschaffenburg *et al*. (43) have discovered an increasing desire on the part of consumers to know what is in their food.

The authors noted several trends in what Americans are eating. Snider (145), for example, discusses data which reveal that the per capita consumption of sugar, fats, and white flour exceeds the consumption of meat, potatoes and vegetables. However, Woodman (181) reports that college students have become more food and weight conscious and have started to rebel against "the food establishment." Meanwhile, food service departments are trying to implement new varieties of food to correspond to new food habits of the student.

Aschaffenburg et al. (43) have noted the emergence of a new cultural pattern in eating: smaller, more frequent, individual mini-meals and fewer family unit meals. This increase in smaller, more frequent meals is reflected by the increased use of vending machine foods, more snacks, more sandwiches, increased buffet services, an increased demand for variety, and a growing demand for quickly prepared frozen snack foods. (Anonymous, 21) As the number of meals consumed by family units decreases, the number of individuals receiving meals through mass feeding programs increases. (Aschaffenburg, 43) The school lunch program, for example, is being expanded to include breakfast; congregate meal programs for the elderly are being developed; and evening meals for children of working mothers are being offered in some areas.

Projected trends. Hearl (88) and Thomas (157) predict that the present economic climate will occasion more and more non-animal foods: Greater use will probably be made of fabricated substitutes for meat and milk. In fact, Thomas (157) predicts that protein substitutes may eventually wean people away from red meats altogether. Increased use of algae and petroleum by-products for protein is forecast by Hearl (88) along with greater reliance on unusual tropical fruits and an increase in fish farming.

New Food Products With Nutritional Attributes

The largest number of nutrition-related articles in the trade literature fell into this category.

New sources of protein. Numerous articles dealt with the use of soy protein either to extend or substitute for traditional sources of protein, particularly meat and poultry (170, 176, 168, 37, 20, 10, 124, 136, 25, and 34). Snider (141) reported that cottonseed flour, which is from 67 to 70 percent protein, has the potential to increase protein in the food supply. Wallace (166) discussed protein produced by fermentation of petroleum. Although this product has been shown to have between 85 and 90 percent digestibility, it cannot serve as a solution in the world's protein problem because of its limited supply.

Those portions of fish that have been wasted can now be stripped from the bone by machine and used as an added source of high quality protein. (Anonymous, 27) Peanuts are now converted to flavored flakes that are palatable and nutritionally superior to soy protein, according to a report in Institutions Magazine (27).

Vernon (164) has reported on a non-dairy cheese produced by Anderson Clayton Foods. It has a protein efficiency ratio (PER) superior to that of natural cheese or casein, and its vitamin and calcium content is reported to approximate processed American cheese.

Dietetic foods. Numerous reports dealt with foods that find wide use in weight reduction diets or among people with hypertension and atherosclerosis (5, 4, 23, 19, 24, 6, and 7). A number of these foods, which are low in calories, sodium, fat, and cholesterol, have recently become available.

Nutrient enriched or fortified foods. Katz (99) reports that many frozen food packers are considering bolstering the nutritional content of their frozen foods with vitamins. Some experts believe that food fortification is a tool manufacturers can use to meet Federal Food and Drug regulations on the nutritional content of frozen convenience dinners. The danger of overfortification or a "vitamin race" between food manufacturers could be diminished, according to Katz, if additives were regulated on the basis of their protein rather than calorie content.

Bread fortified with the essential amino acid lysine was discussed in an article by Woodman (39). According to her, United States Department of Agriculture experts agree that this fortification could help improve the protein quality for undernourished Americans.

Garr (78) reports that the first nutritionally fortified gelatin (with iron, and Vitamins A and C added) has reached the market.

Potential sources of food with a high nutrient content. Jenkins (96) discussed the high nutrient retention achieved in food preserved by freeze drying and emphasized the potential of these products for improving the nutrient composition of the diet. Wallace *et al*. (167) pointed out the high vitamin A and C content of certain weeds and wild grains and suggested the cultivation of these crops.

The Nutrient Requirements of Human, The Nutrient Composition of Meals, and the Role of the Food Service Industry in Meeting Human Nutrient Needs

Nutrient requirements of humans. The food service trade literature gives little attention to the subject of human nutrient need. A need for such information, however, was expressed in an *Institutions Magazine* article (16) which concluded that the American public is generally uninformed about nutrition. According to this article, a large number of Americans find it difficult to distinguish between sound dietary advice and nutritional quackery, partly because the sound advice is often complicated and dull while the quackery is flamboyant.

Food Product Development carried an excellent article by La Chance (109) on the function of food in relation to the physical, economic, psychological, intellectual, and social needs of humans. That article included a brief history of the Recommended Dietary Allowances along with the 1968 tabulation of these allowances. Institutions Magazine presented an informative question and answer section between Nancy Snider (147) and Dr. Jean Mayer on the nutritional requirements of humans and how food service companies can help consumers become more aware of these needs.

Nutritive content of food. Only limited space in the food service literature is devoted to articles dealing with the nutrient composition of meals served by the industry. Folkers (68) presented a brief sketch of the history of the discovery of nutrients, the commercial synthesis of nutrients, and how this has made possible various enrichment programs. And Rosenfield (132) reported a method for evaluating food as a protein source. Rosenfield included tabulations showing the relative nutritive value and usable protein of various foods along with a tabulation of cost effectiveness in terms of usable protein.

Appledorf (42) analyzed several types of restaurant "dinners," including the pizza, hamburger and chicken restaurants. Although the meals typically failed to provide one-third of the Recommended Dietary Allowances as specified for Type A school lunches, they were shown to be good sources of protein and calcium and were considered good buys for the money. Appledorf recommended that some new product be introduced to supply the nutrient when "meals" in these type restaurants are deficient, or that the food be fortified with the missing nutrient.

The role of the food service industry in meeting nutrient needs of individuals. The question of how much responsibility the food service industry bears for its patrons' nutrient consumption was discussed in Institutions Magazine (38). The traditional point of view has been that the consumer is "his own keeper" and that the food service operator has not been appointed steward of his patrons' health. But, according to Institutions, food service operators do care. Furthermore, both public sentiment and legislative action are shifting new burdens of responsibility onto society's manufacturers and sellers and away from its buyers. The critical question becomes: "At what point in the broadening acceptance of these concepts should the food service operator start to worry about what he is selling?"

In answer to questions posed by Institutions writer, Nancy Snider (147), Jean Mayer, the Harvard nutritionist, suggested that food service operators can help improve the diet of their patrons by (1) making more fresh fruits available; (2) cooking vegetables with a view toward nutrient retention; (3) offering substitutes for breakfast egg menus that are high in protein but low in cholesterol, sodium, and calories; and (4) providing information on the menu about the food ingredients and the fats used to fry food.

The authors' review of the food service trade literature reveals that some restaurants are beginning to modify their menus to meet the needs of patrons on weight reduction diets and on special diets for heart disease. Institutions Magazine (38) offers several suggestions to food service operators who want to offer low-calorie items:

1. Present a wide range of low-calorie items, and use greater imagination and creativity in their presentation.
2. Offer low-calorie snacks along with the usual high-calorie pastries.
3. Learn more about the actual caloric content of food; don't rely on preconceived ideas.

Yates (184) suggests that smaller portions and more vegetables should be considered by low-calorie menu planners. Similar suggestions were made by Blair (47) and Wallace (173), who also pointed out that cooking methods that do not increase the caloric value of food should also be emphasized to food service operators planning to offer low-calorie menus.

Lindauer (112) reports that the food service operator who wants to capitalize on the sizable and potentially profitable reducing diet market must use "a total approach,"

1. He must be familiar with basic nutritional requirements.
2. He must use food preparation techniques in keeping with calorie reduction.
3. He must plan appetizing menus.
4. He must set the selling price of the items on the reducing diet menu by the same procedure established for the regular menu.

The relationship of diet to heart disease receives some attention in food service trade literature. Woodman (182, 183), White (179), and Snider (142) have reported on current research related to the causes of heart disease. In passing they discussed the possible role of eggs, meat, and saturated fats as causative agents.

According to a report in Fast Foods (18), the Hilton Hotels are now offering low-cholesterol, low-fat, and low-calorie meals, and they are being received enthusiastically. These menus are based on substantial reductions in or complete elimination of meat, fats, egg yolks, butter, and pan drippings in cooking and baking.

Mass Feeding Programs, Their Impact on Nutritional Status, and Nutrition Education of the Public

The school lunch program. The school lunch program has received considerable attention in the food service trade literature, probably because it is one of the oldest and best established of the mass feeding programs in the United States. Cutlar (60) reviewed the history of this program, including the School Lunch Act of 1946, the Special Milk Program, the Vocational Education Act of 1963, the Economic Opportunities Act of 1965, the Elementary and Secondary Education Act of 1965, and the Child Nutrition Act of 1966. Cutlar also analyzed the success of the program since its implementation as well as the problems of inadequate school lunch facilities and what is being done to correct them.

Problems involved in the regulation and funding of the school lunch program have been raised and discussed in Institutions Magazine

(26). Institutions reported these recommendations of the National Advisory Council on Child Nutrition.

1. School feeding programs should be made available to all children as soon as possible.
2. Participation in the child nutrition programs should increase.
3. School facilities should be made available for summer feeding programs.
4. Action should be taken to ensure that new food products are properly monitored.

Several innovations have recently occurred which are likely to affect the management of the school lunch program and probably the nutritional quality and acceptability of the meals as well. The United States Department of Agriculture ruled that as of April, 1970, schools may hire food caterers to prepare and serve school lunches and still get federal reimbursement. (Barrett, 46) Detroit's school system was the first to buy lunches from a food catering service. Nevertheless, catering firms have been initially cautious about accepting school lunch contracts.

According to Institutions Magazine (22) the USDA is revising the Type A menu file for school lunch more fully to utilize convenience foods; moreover, new recipes using fortified food products are being developed. Kech (100) reported that school lunch directors are trying to encourage children to consume more nutritionally balanced meals by testing various new foods. Such favorites among children as pizza and hot dogs are being used together with more ethnic foods. To compete with fast food restaurants, Tarshis (155) reported that some school lunch directors have installed sandwich bars and smaller seating units to make the cafeterias attractive to students. Kech also pointed out that parents often object to pre-prepared meals for their children; rather they want food prepared "homestyle." Since this is becoming more difficult with rising labor costs, the answer may lie in the use of central preparation kitchens that supply satellite school kitchens where the lunches are served (kech 100).

Other mass feeding programs. According to Bukas (51) school breakfast programs are on the increase throughout the nation. This trend affords a good opportunity for food service operators and food service manufacturers to develop a stronger breakfast business. Hanks (86) has pointed out that food service plays an important role in the day care facilities that are increasing in number and importance. Wallace (172) discusses the expanding food service programs for senior citizens. These programs are being undertaken in an effort to solve the nutritional problems of the elderly.

Computers facilitate mass feeding menu planning. (Anonymous, 15 and Speight, 152) They can store all current recipes, food prices, nutrient data, and palatability factors--all of which must be considered when menus are prepared. The computer assists in such specific functions as planning menu cycles, sizing recipes exactly, and purchasing food and supplies.

Nutrition education. Several articles in the food service trade literature suggest that a need for nutrition education among both the consuming public and the food service operators is being recognized.

(Anonymous, 12, is a typical example.) Wallace (174) too emphasizes the need for more nutrition education. She criticizes dietitians for "keeping professional secrets" and not diseeminating vital nutrition information. Stewart (153) observes that providing a nutritious meal is a logistical problem while consuming this meal is a social and psychological problem. He notes the need for a nutrition education program directed at both parents and children. Food Product Development (8) quoted nutritionist Dr. George Briggs as saying that "proper motivation for correct eating is lacking in the U.S. and that the consumer and the food industry are equally responsible for poor nutrition."

Mass feeding programs appear to be the ideal situation for implementation of nutrition education programs. Snider (147) quoted Jean Mayer's remark that "school lunch programs should be used to acquaint students with the nutritional composition of meals." Mayer thinks posters could be used that display nutrition percentages in the familiar supermarket formats. He suggested that school lunches use standardized recipes, central menu planning, and nutritional content menu charts. He believes that children who become accustomed to nutritional information and learn to place a premium on better foods for five days a week over 12 years will expect to see nutritional information on menus when they leave school.

The Durham, North Carolina, schools are implementing a nutrition education pilot program. According to Hanks (85) the program involves both children and parents in classroom and kitchen training. Institutions Magazine (40) reports that the USDA is conducting a pilot program to study the teaching of nutrition education by teams of classroom teachers and food service personnel. These programs are being conducted in Georgia, Alabama, Florida, Mississippi, and Tennessee.

The fact that nutrition was one of the major aspects included in the tenth annual "Food Systems of the Future" seminar conducted by Cornell University's School of Hotel Administration suggests that need for knowledge of nutrition is being recognized in the food service industry. Topics discussed included obesity, malnutrition, and nutritional labeling.

Government Regulations That Relate to the Composition of Food

The use of additives in food. The food service trade literature reveals that the public's reaction to the use of additives in food concerns many food service operators. Snider (144) reported on a seminar that dealt with the safety of additives in food. Dr. E. N. Foster, director of the Food Research Institute at the University of Wisconsin remarked,

> The biggest problem by far is the fantasy of absolute safety. In spite of all the risks we take every day it is difficult to get anyone to settle for less than 100 percent safety in his food supply.

But none of the technologists, chemists, and nutritionists who spoke at the various meetings called for the repeal of the Delaney Amendment even though many of them had negative things to say about it. Snider (144) felt that no one was ready to "tilt with city hall" over the amendment.

Alfin-Slater (3) and Albrecht (2) reviewed the uses of food additives, the types of studies conducted to determine their safety, the cost of those studies, and the time they require. The issue of artificial sweeteners versus sugar was discussed by Snider (140). She expressed the opinion that the use of sugar in human diets may produce more harmful long term effects than use of artificial sweeteners. Institutions Magazine (143 and 36) reported on the legislation to withdraw diethystilberol (DES) from animal food and quoted E. Brinkerd, Vice-president and Director for Armor and Company, as asserting that the discontinuing of DES in cattle production "will increase the meat bill by $13 per person per year in the U.S."

Nutrition labeling of food. Numerous articles have appeared in the food service trade liaterature dealing with the nutritional labeling regulations that resulted from the 1969 White House Conference on Nutrition recommendations. (Anonymous 13, 32, 33, and 36; Snider 146, 149; and Wallace 175) Though the legislation is mainly aimed at the grocery food industry, Snyder (148) listed four reasons why food service operators should be cognizant of the new regulations:

1. The trend toward an awareness of food wholesomeness began in the 1960's and was capped by the 1969 White House Conference on Nutrition, which raised questions about the value of food both at home and away from home.
2. The public's changing eating habits have resulted in more people eating away from home: "Food service sales gained eight percent in 1972 while grocery sales gained only three percent."

3. Food service contractors have made tremendous inroads into the institutional market in recent years. For example, school lunch programs are relying more on commercial contracts, and the likelihood is that the armed services will begin to contract with commercial food services for their feeding programs. Hospitals, penal institutions, and employee feeding programs have begun to turn to the food service industry. And nearly all of these customers take an avid interest in the nutritional value of food.
4. Increased discussion about quality of food offered in fast food restaurants has resulted from the growing awareness of nutrition generally. Many fast food chains are beginning to try to promote the nutritional value of their food. In doing so they subject themselves to the same seller, according to Dr. Ogden Johnson, director of FDA's Nutrition Division at the time the regulations were being formulated.

Institutions Magazine (16) has expressed the opinion that food service operators may soon find it desirable to include nutritional information on menus. Snider (147) quoted Dr. Jean Mayer as saying, "Ingredient information on menus will give a customer confidence in the product. This product is O.K. because I know what is in it." On the other hand, Cohen (58) doubts that the average consumer can use the information required on food products because he lacks both the ability and the desire.

Conclusion

This review of representative food service journals reveals an awareness in the food service industry of the importance of nutrition. This awareness has not yet, however, become strong enough to influence the practices of most food service operators unless they serve meals under prescribed nutritional contraints. Nevertheless, the same consumer pressures that have brought about nutritional labeling regulations for supermarket food are likely to affect the food service industry. Food service operators of the future will probably bear a greater responsibility for the nutrient composition of the products they sell; thus these operators will have to acquire a greater understanding of nutrition principles.

In light of these conclusions, the authors undertook a thorough review of these three aspects of nutrition as they affect the food service industry:

1. The effects of cooking and processing on the nutrient composition of food;
2. Recent developments that may influence the nutritional quality of meals served in mass feeding programs; and
3. Nutrient labeling regulations and the initial reactions to them.

Effect of Cooking and Processing on Nutrient Composition of Food

Effect of Cooking and Processing Food on Nutrients in General

Preparation prior to cooking and processing. Some nutrient loss occurs particularly in vegetables, during treatment prior to cooking and processing. According to the USDA's *Home and Garden Bulletin No.* 90 (162) on conserving food nutrients, trimming vegetables or removing the coarser outer leaves often results in loss of vitamins A and C and calcium. Bruising vegetable tissue can also cause losses of vitamins A and C, consequently sharp blades are recommended for trimming, cutting, or shredding fresh vegetables. The length of time raw vegetables are stored, as well as their storage temperature and humidity affect nutrient retention, and particularly the retention of vitamin C. Cool, usually refrigerator, temperatures and humidity high enough to prevent withering retain fresh vegetable nutrients best.

Cooking methods. The various cooking methods affect nutrient retention in food differently. This section deals with the effects of moist heat cooking methods, dry heat methods, frying, and microwave cookery.

1. Moist Heat Methods. Boiling, steaming and relatively low temperature pressure cooking are the typical moist heat methods of cooking; and at the temperatures used in such methods, the destruction of nutrients by heat is not great. However, Fox and Cameron (73) point out that water-soluble nutrients, primarily vitamins and mineral elements, may leach into

the cooking water and be lost. This loss increases in proportion to the amount of surface area of the food exposed to water. For this reason, crushing, chopping, slicing and shredding before moist heat cooking increases nutrient loss. Fox and Cameron (73) also report that the vitamin C and protein loss in boiled vegetables is increased approximately 14 percent when the vegetables are cut into small pieces as opposed to the loss that occurs when they are cut into large pieces. Moreover, the loss of mineral salts and sugars is increased by approximately 11 percent.

During moist heat cooking, the action of heat in the presence of air also causes some nutrient loss. Because vitamin C is one of the most easily destroyed nutrients, its retention can be taken as an index of the severity of the cooking process. Fox and Cameron (73) report that less vitamin C is lost during pressure cooking than during either boiling or steaming.

Protein is denatured during any type of heat treatment. But the denaturation that occurs during moist heat cooking generally does not alter the biologic value of protein. Lang (110) states that heat treatment actually improves the digestibility and availability of certain nutrients of foods of plant origin. He further reports that mild heat, like the heat used in moist heat cooking, generally has no detrimental effect on the biologic value of meat, fish, or poultry.

2. Dry Heat Methods--Roasting, Baking, Grilling, Broiling. Dry heat methods of cooking employ higher temperatures, consequently, more heat sensitive nutrients are destroyed. Dry heat methods of cookery affect all classes of nutrients except the mineral salts.

According to Lang (110) excessive heat treatment alters the amino acid composition of protein in such a way that some of the amino acids become bound by linkages that are resistant to enzyme hydrolysis. Consequently, they lose biological value. Although this type of loss is not believed to be excessive in general cooking methods, the destruction of amino acids due to the Maillard reaction is of consequence in the dry heat cooking of some foods. ("The Maillard reaction" refers to the reaction of certain protein-bound amino acids with reducing sugars. The reaction produces enzyme resistant bonds and sacrifices the biologic activity of the amino acids. It occurs in mixtures of proteins and carbohydrates, as they occur in natural foods and is responsible for the browning observed in heated and stored food.)

The reduction in nutritive value of protein due to the Maillard reaction has been studied mainly in terms of lysine loss during cooking. Fox and Cameron (73) report that bread looses from 10 to 15 percent of its lysine during baking and a further 5 to 10 percent during toasting. Some meat lysine is lost during roasting.

The poly-unsaturated fatty acids are susceptible to heat and oxidation, and the content of these fatty acids can be reduced in foods cooked at the temperatures typically used in dry heat cookery.

Vitamin C is unstable at dry heat cooking temperatures, and thiamine, Vitamin B_6, and folacin are among the most readily destroyed of the B vitamins at these temperatures. Riboflavin is not appreciably destroyed by ordinary dry heat cookery, and niacin, too, is quite stable. The percentage of retention of the unstable vitamins will vary with the ph of the cooking medium, the temperature, and the length of cooking time.

3. Frying in Shallow or Deep Fat. According to Fox and Cameron (73), nutrient losses due to frying have not been extensively investigated. But in general they appear to be similar to the losses that occur during roasting. Frying occasions greater vitamin loss in vegetables than roasting, and meat looses some B vitamins as a result of frying.

4. Microwave Cookery. The appearance and flavor of cooked microwave food often differs from conventionally cooked food. But nutrient losses do not appear to differ significantly. (Fox and Cameron, 73) Vitamin C and thiamin retention during microwave cookery have been investigated more extensively because both nutrients are very sensitive to heat. According to Fox and Cameron, vitamin C loss in vegetables appears to depend more on the volume of water used and the cooking time than on the method of cooking. Van Zante and Johnson (163) have reported that thiamin and riboflavin retention differ when the food is cooked in buffered solutions heated conventionally or by microwave methods. Furthermore, Goldblith et al. (81) have attributed thiamin destruction by microwave energy solely to temperature. Microwaves per se have no effect on the destruction of thiamin .

Processing methods. Like the various cooking methods, the various food processing procedures affect nutrient retention. This section deals with food refining, canning, freezing, dehydration, and irradiation.

1. Refining. Nutrient loss during the refining of cereal products is a well established fact. Schroeder (138) has reported

that processed and refined grains lost from 50 to 86.3 percent of their thiamin , riboflavin, niacin, vitamin B_6, pantothenic acid, folacin, and vitamin E. He further pointed out that the refining process caused a substantial reduction of 13 minerals. The grain enrichment program in the United States results in the addition of thiamin , riboflavin, niacin, and iron to several types of refined grains. But obviously all of the nutrients lost during refining are not restored.

2. Canning. The undesirable effects of heat processing according to Lund (117) include changes in protein and amino acids, carbohydrate, lipids, vitamins and minerals. As in cooking, proteins and reducing sugars undergo the Maillard reaction in the canning process. The essential amino acids, lysine and threonine are the most heat labile. Lund further states that while carbohydrate loss generally does not worry nutritionists, some does occur via the Maillard reaction. Significant losses of water soluable vitamins and minerals, however, do occur in the washing and blanching steps during the canning process. And the water soluble vitamins, particularly vitamin C and thiamin , are further degraded in the retorting operation. Fat soluble vitamins are not lost due to leaching in the washing water and they are generally less heat labile than water soluble vitamins. But some degradation of fat soluable vitamins does occur at high temperatures in the presence of oxygen.

Goldblith (79) lists the four major points at which nutrients may be lost during the canning process:

a. Raw product handling between harvesting and canning. "Fresh or well-refrigerated raw foods display a higher vitamin retention than second-grade raw stock; this is the basis for the axiom that one cannot improve a product by processing."

b. The time-temperature mix employed in hot water blanching. "Hot water blanching leaches out water-soluble vitamins. High temperature short time (HTST) water blanching enhances nutrient retention, and steam blanching improved the retention of water soluble nutrients over water blanching procedures." Voirol (165) reported that either blanching by immersion in steam or a treatment with microwaves conserves nutrients better than hot water blanching. But the former two methods are technically more difficult to control because they require specialized apparatuses.

c. The time-temperature relationship employed during heat processing. HTST sterilization processes result in significant nutritive savings. Higher vitamin retention also occurs during the agitating processes than with conventional still retorting.

d. The time and temperature of storage. Canned foods are not absolutely shelf stable. Storage temperature can cause post-processing changes. Much of the nutritive advantages gained by HTST processing can disappear if canned products are stored at ambient or warm temperatures, from 70 to 90 degrees F. The need for cool storage is evident.

3. Freezing. Cain (54) has stated that "freezing per se does not injure vitamins. It is the mishandling both before and after freezing which lowers the vitamin content, as compared to that of raw material." This observation is generally true for other nutrients as well as

vitamins. The washing and blanching process that precedes freezing effects water soluble nutrients in the same way as the washing and blanching that precedes canning.

The method of cooling the product following blanching can also affect nutrient retention, particularly the retention of vitamin C. Cool air methods of arresting the blanch destroy more vitamin c than cooling with water. (Cain, 54) Cain further points out that alterations in freezer temperatures which produce freezing and thawing during storage are particularly destructive to vitamins.

Two types of freezing seem to be particularly successful in preserving food palatability. These are "quick-freezing" ("those processes in which the thermal center of a food pack passes through the zone 0 degrees C to -4 degrees C in 30 minutes"), and cryogenic freezing in which food is frozen nearly instantaneously in liquid nitrogen. (Fox and Cameron, 73) Neither of these freezing processes affect the nutrient content of food. But some nutrient loss does occur during freezer storage even when temperatures remain below -18 degrees C. The degree of nutrient loss during storage depends upon the storage temperature and the storage time. The loss of vitamins, and in particular vitamin C, increases as storage temperatures either increase or fluctuate and as storage time increases.

Fox and Cameron (73) have emphasized that thawing of frozen products slowly increases nutrient loss. This effect is due partially to drip loss of minerals and vitamins and partially to vitamin degradation as the thawing process proceeds. For this reason, it is usually best to cook frozen products without thawing.

4. Dehydration. Two specific kinds of dehydration concern us here, thermal dehydration and freeze dehydration (or "freeze drying").

a. Thermal dehydration. Labuza (113) has reviewed the effects of thermal dehydration and storage on nutrient retention. In dehydration, the moisture content of food must be lowered to below 50 percent on a wet weight basis before protection is afforded against micro-organisms. Removal of water by dehydration causes the dissolved components to be concentrated unless they crystallize out. The temperature is raised in order to supply the necessary energy to transform the water to vapor and thus, reactions between components can be accelerated during drying as well as during the storing of the dehydrated food.

According to Labuza (107), two types of reactions are responsible for nutrient loss during drying and storage of food. The first is the "per se" effects of the process itself, and the second is the interaction between compounds produced during storage or drying and various nutrients that renders them biologically unavailable. Loss of protein biological activity has resulted from thermal dehydration of several foods. Once again, the Maillard reaction seems to be the culprit: lysine and other amino acids react with reducing sugars. De Groot (62) reports that dehydration in hot air generally results in some slight protein damage, while dry spray drying or freeze drying causes less damage.

Cain (54) has reported that the thermal dehydration process itself causes only moderate losses of the B vitamins but that protection of vitamin C is particularly difficult to achieve and losses may be extensive. Puff drying under vacuum retains most of the vitamin C present, and the Flash-18 process developed by Swift and Company has resulted in significantly higher retention of thiamin and riboflavin.

Most of the loss of fat-soluble vitamins in thermal dehydration and storage can probably be attributed to the interaction of peroxides of free radicals with the vitamin. Labuza (107) maintains that lipid oxidation is the source of the peroxides and radicals, and anything to prevent lipid oxidation should increase the retention of at least vitamin A and vitamin E. Labuza further states that storing foods under low-oxygen conditions reduces the rate of vitamin destruction by a factor of ten.

Labuza further emphasizes the need to obtain more information about nutrient destruction and particularly about vitamin and protein biological value during dehydration. The data is needed as a function of A_w or moisture content, temperature, and oxygen concentration.

Labuza (107) has pointed out that moisture content of any type of dehydrated product affects nutrient retention during storage. The higher the moisture content the greater the loss of water soluble vitamins and protein but the lower the destruction of fat soluble vitamins.

b. Freeze-dehydration. Hollingsworth (98) reports that the nutritive value of protein is unaffected by the low temperatures used during freeze-drying, and there is little or no deterioration during storage. However, palatability changes do occur in some foods.

Goldblith *et al.* (80) note that freeze-dehydration and subsequent storage produce ill-defined changes thought to be related to food protein. These changes include tissue toughening in seafood and meat products.

Focusing on vitamin and nutrient retention in freeze-dried foods, Hollingsworth (93) states that when the reconstituted freeze dried products are cooked, the combined processing and cooking losses will approximate the losses when fresh food is cooked.

5. Irradiation. Preservation of food by ionizing radiation is reported by Hollingsworth (93) to have approximately the same effect on nutrient retention as ordinary cooking. Thiamine is particularly sensitive and vitamin C and B_6 are also susceptible to destruction by irradiation. Cain (54) reports that the action of ionizing radiation on vitamin C solutions depends on the concentration of the vitamin and the radiation dose. Vitamin C retention increases as the concentration is increased. According to Kraybill (104) vitamin B_{12} is even more sensitive to ionizing irradiation than vitamin C.

Hollingsworth (93) points out that the effect of ionizing irradiation on fat soluble vitamins, particularly Vitamin D, requires more research. Furthermore, little information exists about the losses of nutrients on cooking that follows irradiation.

Effect of Cooking and Processing on Flesh Foods

Flesh foods (meat, fish, and poultry) are collectively considered the major contributors of high quality protein to the diet.

This group also provides iron and several of the B vitamins, particularly thiamin , riboflavin, niacin, and vitamin B_6. Thiamin is probably the most unstable member of this group, and its retention is often taken as an indicator of the respective nutrient retention properties of the various flesh food cooking and processing methods.

Conventional cooking of flesh foods. Burger and Walters (52) have reviewed the effect of cooking and processing on nutrient retention of flesh foods. They report thiamin loss in these foods of from 15 to 60 percent. Moderate cooking methods are said to result in losses of about one-third of vitamin B_6 and B_{12} and one-tenth of riboflavin, niacin, and pantothenic acid. Studies quoted by Burger and Walters (52) demonstrate vitamin A losses from meat of 40 percent after five minutes of frying at 200 degrees, 60 percent after ten minutes, and 70 percent after 15 minutes of frying. Available beef and fish lysine also decreases as cooking temperatures increase. But these lysine losses may not alter the total nutritive value of food unless protein in the diet is limited.

Other studies show that thiamin retention in cooked meat is poorer than riboflavin or niacin retention. Noble (126) studied thiamin and riboflavin retention in five cuts of braised beef. Thiamin retention ranged from 23 to 40 percent. Mayfield and Hedrich (119) reported similar results in roast beef. Bowers and Fryer (49) found thiamin retention in conventionally cooked turkey to be 79.3 percent while riboflavin retention was 91.8 percent.

Studies done by Lin and Ritchey (113) indicate that the quality of turkey protein was not reduced due an electric oven heated to either 163 degrees C. or 228 degrees C. for two hours. However, the nutritional quality of the turkey protein was damaged when it was heated in an autoclave for 24 hours. Of course severe treatment like this is not likely to occur under practical conditions.

The method of cooking used also affects the nutrient retention of flesh foods. For example, Burger and Walters (52) report thiamin losses ranging between 15 and 40 percent when flesh is broiled, 40 to 60 percent when it is fried, and 30 to 60 percent when it is roasted. Cover and Smith (59) found that thiamin and niacin retention remained higher in broiled beef steaks than braised beef steaks. The meat of beef roasts, cooked of course by dry heat, contained less thiamin but more niacin than the meat of pot roasts cooked by moist heat. Noble (125) reported that pan- and oven-broiled cuts of beef, pork, and lamb showed essentially the same percentages of thiamin and riboflavin retention. In another study, Noble (127) found that braised meats retained a larger proportion of thiamin than simmered meats, but by contrast the simmered meats retained riboflavin better.

Microwave cooking of flesh foods. Several research groups (49, 124, and 106) have found that riboflavin and thiamine retention in meat cooked in microwave ovens is generally similar to that cooked by conventional methods. But studies reported by Wing and Alexander (178) reveal that cooking chicken breasts by microwave results in significantly greater vitamin B_6 retention than roasting by conventional heat. Not only did the conventional heat roasting result in a larger drip volume, but the vitamin B_6 in this larger volume was more concentrated as well.

Heat processing (canning and thermal dehydration) of flesh foods. Burger and Walters (52) have reported that heat processing of flesh foods including canning is responsible for some reduction in protein value as a result of the destruction or reduced availability of the constituent amino acids. Generally speaking, three types of reactions are responsible for these changes:

1. The Maillard reaction,
2. Cross-linkage reactions that result in bonds resistant to enzymatic hydrolysis in the gut, and
3. Damage to sulfur amino acids by oxidation or desulphydration.

Prolonged heating at high temperatures can cause extensive damage to the protein quality of flesh foods, but again, these conditions are seldom encountered in normal commercial processing.

The heat processing involved in flesh food canning results in the loss of several vitamins. Studies reported by Burger and Walters (52) show that the thiamin loss in canned beef, veal, pork, lamb, poultry, and fish ranged from 55 to 84 percent. Riboflavin and niacin losses, however, were generally low. These authors also discovered that commercial heat processing (canning) resulted in 30 to 40 percent destruction of pantothenic acid. Schroeder (138) found that the mean loss of vitamin B_6 in ten canned seafoods was 48.9 percent, while the mean loss in four meats was 42.6 percent.

Everson et al. (67) reported on thiamin and vitamin B_6 retention of aseptically canned, strained beef that had been processed by HTST sterilization. (Everson et al., 67 and 66)

They found no difference in the vitamin B_6 retention of the aseptically canned beef and the conventionally canned product; however, thiamin retention of the aseptically canned beef was 92.8 percent versus 80.1 percent for that of conventionally canned beef. Loss of both thiamin and B_6 occurred during storage of the canned beef, and this phenomenon appeared to be unrelated to the type of canning process used.

Thermal dehydration causes a great deal of thiamine destruction in flesh foods. Calloway (55) reported that from 50 to 70 percent of the thiamin in pork is destroyed by thermal dehydration although neither riboflavin nor niacin is damaged to any appreciable extent. A 30-percent loss of pantothenic acid occurred in heat-dried beef.

Freeze Dehydration of Flesh Foods

Burger and Walter (52) report conflicting results on the effect freeze drying has on the protein quality of flesh foods. One study showed no significant effect of this process on the protein quality of beef, fish or chicken; another indicated that freeze drying causes a deterioration of protein quality in meat as a result of the protein or amino acid degregation in the Maillard reaction. This deterioration could have occurred during storage rather than as a direct result of the freeze drying process. Rowe _et al_. (135) found no loss of thiamin , riboflavin or niacin in freeze dried chicken, but Karmas _et al_. (98) reported a 33-percent loss of thiamin in freeze dried pork. Conversely, Thomas _et al_. (160) found that most of the thiamin in pork products remained during freeze drying. The Thomas group studied five representative flesh foods--chicken, beef, pork, shrimp, and bacon--and compared their nutritional quality after preservation by freeze dehydration, irradiation, and conventional thermal processing. In general, their results indicated that among the methods and products studied, nutrient content was least affected by freeze drying.

Kramer (103) has emphasized that cool storage temperatures are essential to preserve the nutritive quality of dehydrated flesh foods. At storage temperatures of between 30 and 40 degrees F., dehydrated pork retained 90 percent of its thiamin for twelve months, but at 70 degrees, the loss of this vitamin was over 25% after only one month of storage.

Freezing of flesh foods. According to Mapson (118) there is no evidence of nutrient loss in flesh foods due to the freezing process, but losses do occur during freezer storage and thawing. Pork stored at either -18° C. or -26° C. retained 60 percent of its thiamine, 69 percent of its riboflavin, and 100 percent of its niacin. (Burger and Walters, 52) Burger and Walters report that additional fat oxidation poses another problem during freezer storage. Oxidation can have a marked destructive effect on vitamins A and E. Measures currently being used to impede oxidation include low temperature storage (-30° C., for example), the rigorous exclusion of oxygen from the packaged product, and the use of such antioxidants as BHT (butylated hydroxytoluene).

Irradation of flesh foods. Reports on the effect ionizing irradiation has on the protein quality of flesh foods conflict. Melta and Johnson (120) found the digestibility and biological value of beef to be unaffected by irradiation, and according to Reber and Bert (130) the protein quality of irradiated shrimp equaled that of untreated shrimp. But Tsien and Johnson (161) reported that irradiation seriously reduced the levels of aspartic acid, serine, and glycine in beef. These findings may not, however, indicate any reduction of protein quality since aspartic acid, serine, and glycine are not essential amino acids.

Irradiation of turkey severely reduced the thiamin content according to Thomas and Calloway (159), but the reduction of riboflavin was not as extensive, and niacin was quite stable. Day et al. (61) reported that the irradiation of ground beef resulted in destruction of riboflavin and pyridoxine, but they found little effect on inositol, niacin, or tryptophan.

Curing of flesh foods. Studies reported by Burger and Walters (52) reveal that curing flesh foods produces only small nutrient losses. Consistent losses of thiamin have been found (up to 26 percent), but the destruction of riboflavin and niacin were generally low. Protein quality of cured meat has been reported to equal that of raw beef, but some instances of reduction in available lysine have been noted.

The Effects of Cooking and Processing on the Nutrient Value of Milk and Milk Products

The cooking effects on the nutritive quality of milk resemble the effects of those processing methods that involve heat treatment. The extent of nutrient destruction depends upon the temperature and the length of cooking time. Therefore we do not intend to examine the effect of cooking on milk separately; rather we will review the various types of heat treatments of fluid.

Milk and milk products are relied upon for calcium, protein, riboflavin, and some vitamin A. Many such products are fortified with vitamin D. Rolls and Porter (131) recently presented an excellent review of the effects of processing and storage on the nutritive value of milk and milk products.

Processing of liquid milk. According to Rolls and Porter (131) the major methods of processing liquid milk include the following:

1. Methods for short-term storage (processed products will remain unaffected several days if kept cool).
    a. Pasteurization by the "holder-process" in which milk is heated to between 61 and 65 degrees C. for 30 minutes.
    b. Pasteurization by the High-Temperature Short Time (HTST) process, in which milk is heated to between 71 and 73 C. degrees for 15 seconds.
2. Methods for longer-term storage
    a. In-bottle sterilization, which involves heating bottled, homogenized milk to between 110 and 115 degrees C. for from 20 to 40 minutes.
    b. Ultra-high Temperature (UHT) sterilization, which involves heating milk to between 130 and 150 degrees C. for one second and then either filling it aseptically into suitable sterilized containers or filling it into nonsterilized bottles and

resterilizing by heating to from 110 to 120 degrees C. for from 15 to 20 minutes.

Rolls and Porter (131) report that the fat, the fat soluble vitamins, the carbohydrates and the minerals of milk remain essentially uneffected by heat treatment. Pasteurization and the UHT aseptic filling process have little effect on the net protein utilization (NPU) of milk protein, but in-bottle sterilization and in-bottle resterilization of UHT milk causes losses in true digestibility, and a fall in the milk's biologic value due to reduced availability of lysine and methionine.

According to Rolls and Porter (131), the effect of heat processing of liquid milk varies with the vitamin in question and the harshness of the treatment. Four of the B-complex vitamins, riboflavin, niacin, pantothenic acid, and biotin are unaffected by all the heat processes. The only vitamin affected by conventional pasteurization is vitamin C which is reduced by from 20 to 25 percent. In-bottle sterilization resulted in a 35 percent loss of thiamin , a 50 percent loss of vitamin B_6 and folacin, and a 90 percent loss of vitamin B_{12} and vitamin C. The UHT resterilization process caused 20-percent losses of thiamin , B_6 and B_{12}, a 30-percent loss of folacin, and a 60-percent loss of vitamin C. The UHT aseptic filling process caused the least destruction of water soluble vitamins with only a 10-percent loss of thiamin , B_6, B_{12}, and folacin, and a 25-percent loss of vitamin C.

Storage conditions also affect the nutrient retention of milk. Regardless of any prior treatment, significant losses of riboflavin, vitamin C, and vitamin B_6 occur if milk is exposed to direct sunlight, diffused daylight, or fluorescent light. Also the level of residual oxygen in milk will have a marked effect on its retention of folacin and vitamin C. Rolls and Porter (131) point out that "from a nutritionist's viewpoint, the elimination of oxygen before storage is desirable, although this may result in a product with a more persistent 'cooked' flavor."

Concentrated milks. Milks from which water has been removed or that have been heat sterilized consist mainly of evaporated and sweetened condensed milks. According to Rolls and Porter (131), the nutrient losses in evaporated milk are in general the same as those in in-bottle sterilization. Storage of this product for several years results in progressive losses of Vitamin C, vitamin B_6, vitamin B_{12}, and possibly riboflavin and folacin as well. Losses of the amino acid lysine become apparent after a year's storage, which in many cases result in a reduction of milk's biologic value to below that found after the initial treatment. Addition of sucrose to sweetened, condensed milk produces considerable bacteriological safety, consequently less drastic heat treatment is necessary and nutrient losses are in the same order as those that occur during pasteurization.

Dried milk. Dry milk is dried by two methods: spray-drying or roller-drying. Neither method has a marked effect on the vitamin content or protein value of milk according to Hodson (91) and Rolls and Porter (131). However, the roller-drying method is the harsher method, so far as protein quality is concerned and if not done efficiently it can reduce the biologic value of milk protein because of the decreased availability of the amino acid lysine and methionine it causes.

If storage conditions are satisfactory, dried milk powders can be kept for several years with little protein or vitamin loss. Rolls and Porter (131) point out that cool storage temperatures and low relative humidity are important factors in keeping the moisture content of the powder below 5 percent and thus preventing the Maillard reaction from occurring. (The Maillard reaction reduces the availability of amino acids.)

Irradiated milk. Sterilizing milk with ionizing irradiation, report Melta and Johnson (120), reduce its biologic value below that of heat sterilized milk. Kraybill (104) reports that vitamins A, E, and C in milk are highly sensitive to ionizing irradiation and that riboflavin is moderately sensitive.

Cheese. Rolls and Porter (131) state that the proximate composition of different whole-milk cheeses are similar even though the preparation techniques vary greatly. The proteins of these cheese are slightly inferior to those of whole milk because the whey proteins, with their higher content of sulfur amino acids, are lost. Partition of the curd and whey also causes the loss of significant amounts of niacin, vitamin B_6, vitamin B_{12}, folacin, vitamin C, and lactose. During "ripening," the remaining vitamin C is lost, but several of the B vitamins may be synthesized.

Filled and imitation milks. Brink *et al*. (50) compiled an extensive review comparing the nutritional value of milk with "filled" and imitation milks. They define filled milk as "a product made by combining fats or oils other than milk fat with milk solids, with the resulting product in the semblance of milk." The type of milk solids included in this definition are "any milk, cream, or skimmed milk, whether or not condensed, evaporated, concentrated, powdered, dried or desiccated." The Food Drug Administration (70) is seeking to find more suitable common names for such products and to establish standards and labeling for these foods. Imitation milk "purports to be, or resembles, milk but contains no milk products as defined above." The Food and Drug Administration (69) regulations now dispense with the term "imitation," and common or usual names are used for such products.

Two types of filled milks have been identified by Brink _et_ _al_. (50):

> One is a combination of fluid skim milk, with or without skim milk solids, and a vegetable fat made in the semblance of milk. A second type basically contains water, nonfat dry milk, vegetable fat, and an additional source of protein such as soy protain or sodium caseinate.

The fat used in filled milk is usually hydrogenated coconut oil which is high in saturated fatty acids and low in unsaturated fatty acids. These products contain the nutrients of skim milk to the extent that skim milk is used, and some are fortified with vitamins A and D. Brink _et_ _al_. further reported that the protein and amino acid content of the filled milks studied compared favorably with fluid whole milk. However these investigators point out that imitation milk products can in no sense be considered replacements for milk in terms of protein, minerals, and vitamins. In fact, the products analyzed in the Brink study contained only one percent protein.

Cooking and Processing Fruits and Vegetables

Fruits and vegetables are relied upon for their contributions of vitamins A and C and some minerals including iron and calcium. For this reason the retention of vitamins A and C during the cooking and processing of vegetables has received considerable attention.

Effect of cooking. Fox and Cameron (73) reported on the comparative retention of vitamin C in brussels sprouts, cauliflower, peas, and spinach subjected to three different cooking methods. Retention ranged from 70 to 81 percent during boiling; from 68 to 91 percent during steaming, and from 80 to 97 percent during pressure cooking. The effect of the length of cooking time on vitamin C retention in these vegetables was also reported. In brussels sprouts and carrots, 12 percent more of the vitamin was lost when the cooking time increased from 20 to 30 minutes, whereas the loss in cabbage was increased by 61 percent when the cooking time was increased from 30 to 90 minutes. The loss in potatoes increased by 43 percent when the cooking time increased from 30 to 90 minutes.

Vitamin A activity in fruits and vegetables has generally been considered stable under most cooking conditions. Recent work by Sweeney and Marsh (154), however, has revealed that some vitamin A activity is lost during cooking. Some of the carotene precursors of Vitamin A in the raw foods is converted to less biologically active forms of carotene. This conversion reduced the Vitamin A activity in the green vegetables by between 15 and 20 percent, while the reduction in yellow vegetables attributable to cooking ranged as high as between 30 and 35 percent in some cases.

Loss of minerals during cooking of fruits and vegetables can be attributed to leaching. Krehl and Winters (105) determined the loss of calcium, iron, and phosphorus in twelve different vegetables cooked in varying amounts of water. Their data revealed that greatest retention of the minerals occurred when the vegetables were cooked with no added water, and the least retention was found when cooking water covered the vegetables. Teply and Derse (156) studied the effect of cooking 20 different frozen vegetables in one-quarter cup of water. They found little leaching of nutrients into the liquor, except in the case of turnip greens. Little degradation of thiamin , niacin, and riboflavin occurred. Retention of beta-carotene, folic acid, pantothenic acid and vitamin B_6 was generally good, but in a few cases there was a 50-percent loss. The lowest retention of vitamin C appeared in cut green beans, sliced collard greens, cut corn, and chopped spinach, all of which registered a loss of between 52 and 73 percent. There was, however, over 90-percent retention of vitamin C in a number of products.

Conflicting evidence has been reported on the effect of microwave cookery on nutrient retention capacities in vegetables. Kylen _et al_. (106) found no significant difference in vitamin C retention when green beans, broccoli, cauliflower, and soybeans were prepared by microwave cookery and by conventional cookery. Thomas _et al_. (158) found the retention of several water soluble nutrients in vegetables to be better in pressure cooking then in either boiling or microwave cooking.

Gordon and Noble (82) reported that cauliflower and cabbage cooked by microwaves retained more vitamin C than the same vegetables cooked in pressure saucepans, or boiling water. The magnitude of the difference in vitamin C retention in all of these studies was small, however. Thus Cameron and Fox (73) conclude that the general loss of vitamin C in vegetables depends more on the volume of water used and the cooking time than on the method of cooking.

Effect of canning. Nutrient loss in canned foods may occur during washing and preparation, blanching, sterilization, and storage. According to Cain (54), vitamin C is more abundant in the apple peel than in the cortex used in apple slices. The "waste" core of pineapple, moreover, contains more vitamin C than the flesh; and niacin seems to be richer in the epidermal layer of carrot root than in the part that remains after peeling. Cain (54) further reports studies which reveal that a slightly greater loss of vitamin C, niacin, and thiamin in peas, green beans, and lima beans occur as blanching temperatures and blanching times increase. Steam blanching occasions more thiamin retention in these vegetables than water blanching. Peas and beans blanched by the microwave methods retained more vitamin C than peas and beans blanched in water, but about the same amount as peas and beans blanched in steam. Eheart (65) found that broccoli blanched in microwave retained more vitamin C than broccoli blanched in water.

Data reported by Goldblith (79) revealed that high temperature short time (HTST) sweet pea blanching enhanced the vitamin C and thiamin retention over that obtained by regular water blanching.

The mean total loss of vitamin C in commercially canned asparagus, lima beans, and spinach ranged from 5 to 33 percent; niacin retention ranged between 6 and 17 percent; thiamin between 8 and 42 percent; and riboflavin from 10 to 24 percent. (Cain, 54) Shroeder (138) studied itamin B_6 and pantothenic acid losses in 22 canned vegetables and 24 canned fruits and fruit juices. Compared to the raw product, B_6 losses in the vegetables ranged from 57 to 77 percent, while pantothenic acid losses ranged from 46 to 78 percent. The mean loss of Vitamin B_6 in the fruits and fruit juices was 37.6 percent; pantothenic acid figure was 50.5 percent.

Sweeney and Marsh (154) found that the reduction in vitamin A activity of green and yellow vegetables attributable to canning resembled the usual loss during cooking.

Nutrient retention in fruit and vegetable products canned by the aseptic process has received some attention. Data reported by Cain (54) revealed that strained lima beans lost 15 percent of their thiamin in the aseptic process versus 42 percent in the conventional process. Essentially 100 percent retention was obtained in tomato juice concentrate. However, storage of these products at 86° F. for nine months caused a 28-percent loss of thiamin in the beans regardless of their processing method and at least a negligible loss in the tomato juice. Lun and Sioud (116) studied the stability of aseptically canned pear puree. High temperature storage caused discoloration, faster corrosion of the tin coating of the container, and formation of hydrogen gas in the head space, but the investigators report no nutrient values. Thiamin retention in conventional and aseptically processed plum tapioca and split peas with ham (baby food) was reported by Bongalon et al. (48). Retention was higher in the aseptically processed products. Losses that occurred during storage were traced to storage temperatures and time spans. Chen et al. (56) found that the aseptic canning process allowed a higher level of free amino acids in canned strained peas. Everson et al. (66) found a higher retention of thiamin in aseptically canned strained lima beans than in conventionally canned ones, whereas the vitamin B_6 retention of strained beans canned by these two methods was about the same.

Vitamin retention in canned, stored vegetables also depends on the storage temperature. According to Kramer (103) canned peas, green beans, and lima beans lose just a small percent of their vitamin C content when stored at temperatures below 40 degrees F., but they lose about 15 percent when stored at 80 degrees F., for up to one year and about 25 percent when stored at this temperature for longer than one year. Significant losses of thiamin also occur in canned vegetables when storage temperatures are ten degrees lower. According to Cain (54), low-acid canned vegetables retain less thiamin than canned fruits retain. Up to a 50-percent loss can be expected in canned vegetables after 24 months of storage at 80 degrees F. Thiamin loss in tomato juice stored one year at 85 degrees F. was 15 percent, but the loss increased to 69 percent when the juice was stored at 110 degrees F. for a year. Orange, grapefruit, and tomato juice stored at a temperature range of between 50 and 80 degrees F. for 24 months lost only 25 percent of its thiamin.

Vitamin C retention in citrus juices is a very important topic since these juices are popularly accepted as prominent sources of the vitamin. Cain (54) reported that canned citrus juice processed under present practices retain between 92 and 97 percent of their ascorbic acid and that low values in the products purchased on the open market probably stem from improper storage practices. According to Kramer (103), fruit juices stored at 40 degrees F. or less lose very little vitamin C even after 12 months. If they are held at higher temperatures, however, the loss is great. For example, over half the vitamin C may be lost in four months if fruit juices are stored at 98 degrees F.

Effect of freezing on the nutrient retention of fruits and vegetables. The actual freezing process has very little effect on the nutrient content of fruits and vegetables. Rather, losses occur during the blanching process and during storage, and the losses depend upon the length of storage time and the blanching temperatures.

Blanching losses are essentially the same as those that occur in the blanching that precedes canning. Kramer (103) has reviewed the effects of freezer storage on fruits and vegetables and has found that asparagus, green and lima beans, and peas stored at -5 degrees F. maintain at least 90 percent of the original vitamin C content for 12 months. However, lower storage temperatures are desirable for broccoli, cauliflower, spinach, and peaches because these foods will lose from 20 to 50 percent of their vitamin C when stored for 12 months at temperatures as high as only 5 degrees F. Vitamin C in orange juice, however, is quite stable for two years at 0 degrees F., and less than

10 percent is lost at temperatures as high as 40 degrees F.

Other reports confirm the stability of vitamin C in frozen orange juice. Rakieten et al. (129) reported that vitamin C values of fresh-frozen orange juice (reconstituted concentrate) showed a higher average value than freshly squeezed orange juice. No significant losses of ascorbic acid took place either in fresh-frozen or in freshly squeezed orange juice when stored at ordinary refrigerator temperatures for as long as 24 hours. Lopez et al. (115) found little loss in the vitamin C content of reconstituted frozen orange juice after eight days of refrigerator storage. Orange juice also retains its folacin content rather well. (Butterfield, 53).

Schroeder (138), studying vitamin B_6 and pantothenic acid in frozen vegetables, fruits and fruit juices found that vitamin B_6 losses in 22 vegetables ranged from 37 to 56 percent while the pantothenic acid losses ranged from 37 to 52 percent. The average B_6 loss in 24 fruits and fruit juices was 15.4 percent while the pantothenic acid loss was 7.2 percent.

Effect of dehydration on fruits and vegetables. Calloway (55) has reviewed the effects of thermal dehydration on vegetables. Retention of beta-carotene (the vitamin A precursor) is reported to range from 70 to 100 percent of that found in the raw product. Only marginal losses of riboflavin, niacin and pantothenic acid have been found as a result of heat dehydration. The use of sulfite in dehydrated foods is, however, quite detrimental to thiamin retention. Unsulfited dehydrated vegetables will usually retain between 80 and 90 percent of their thiamin , but only about 25 percent is retained in the sulfited product. Conversely, sulfiting encourages vitamin C retention. Thomas and Calloway (160) report that sulfited, dehydrated cabbage retained large amounts of vitamin C. But Calloway (55) emphasized that losses of vitamin C in the presence or absence of sulfite is extremely variable in thermally dehydrated vegetables, ranging from complete destruction to good retention with 50 percent being an accepted average value.

Freeze-dehydration of fruits and vegetables. According to Hollingsworth (92) more research into the nutrient retention properties of freeze-dried foods must be done. Loss of vitamin C in freeze-dried vegetables can be as low as 10 or 20 percent, including the vitamin C lost during blanching before the drying process. Steam scalded, freeze-dried peas retained from 80 to 92 percent of their vitamin C. Cooked, freeze dried carrots approximated to cooked raw carrots in beta-carotene (pro-vitamin A) content. Sweeney and Marsh (154) reported similar results in freeze dried carrots.

Weits *et al*. (177) compared nutrient losses in canned, frozen, thermally dehydrated, and freeze-dried spinach, peas, and green beans. They found vitamin C retention lowest in canned and thermally dehydrated vegetables and highest in the freeze-dried and frozen ones. Thiamin retention was better in the thermally dehydrated and freeze-dried products and poorest in the canned. Little riboflavin, potassium, iron, or calcium was lost during the various processing procedures.

Regardless of the method of dehydration, storage conditions can profoundly affect the nutrient retention of dried fruits and vegetables. Hollingsworth (92) has reported that vitamin C loss occurs when dehydrated fruit is stored in air. Fruit bars made of dried apple, lemon, and sugar stored at 18 degrees and 37 degrees C. lost vitamin C more rapidly than when stored in nitrogen. At 18 degrees C., the average loss was 74 percent in air compared with 57 percent in nitrogen. At -5 degrees C., however, losses in both air and nitrogen were small.

Calloway (55) reported that dehydrated orange juice stored at room temperatures loses practically no vitamin C provided the moisture content is "very low."

Kramer (103) notes these effects of storage conditions on nutrient retention in dehydrated vegetables: Tomato flakes lost practically no vitamin C when stored at 40 degrees F. at moisture levels of from 1 to 5 percent. However, when storage temperatures were 70 degrees F. and moisture 1 percent, vitamin C loss was 10 percent; it increased to 30 percent at 5 percent moisture levels. A storage temperature of 100 degrees F. produced a 30 percent vitamin C loss within a 32-week storage period even though the moisture level was only 1 percent, whereas a 5 percent moisture level at the 100 degrees F. resulted in an 80 percent vitamin C loss. To retain the vitamin C content of dehydrated onions, cabbage, white potatoes, and rutabagas for one year, Kramer found storage temperatures of between 30 and 40 degrees F. to be necessary. Kramer concluded that "the only way of maintaining both sensory and nutritional quality of dried foods, for extended time periods, is to store them at the appropriately low temperatures and low relative humidities, particularly if the dried products are not packed in air-tight containers."

Effect of Irradiation of Fruits and Vegetables. Studies reported by Cain (54) indicate that ionizing irradiation of fruit caused no significant loss in vitamin C if the level of irradiation was such that the fruit was otherwise acceptable. Irradiated green papayas and mangoes exhibited no reduction in their vitamin C content. A dose rate effect on vitamin C content was reported when strawberries were exposed to gamma radiation. Thomas *et al*. (160) reported that irradiation of cabbage oxidized all of the ascorbic acid to the dehydro form. Most of this was further oxidized when the cabbage was cooked, resulting in a very low retention of vitamin C.

Effect of Cooking and Processing on Eggs

Fox and Cameron (73) have pointed out that cooking of eggs results in little loss of nutritional value except that, on the average, 20 percent of the thiamin and 10 percent of riboflavin are destroyed. Burger and Walters (52) have reported that neither the freezing nor the freeze-drying process have any significant effect on the nutritive quality of eggs. Thermal dehydration of eggs can, however, result in a loss of protein value if a harsh heat treatment is used.

Dehydrated eggs may lose nutrients during storage. According to Burger and Walters (52), egg dehydration involves a desugaring process that removes glucose from the eggs and subsequently improves the stability of the dried product during storage. Nevertheless, Kramer (103) has reported that dehydrated eggs should be held in freezer storage if satisfactory levels of nutrients, particularly vitamin A, are to be maintained for longer than one month. A vitamin A retention of 90 percent was obtained in dehydrated eggs held for 12 months at a temperature of -10 degrees F. If the storage temperature was raised to 0, vitamin A loss during one year exceeds 25 percent. It reaches 50 percent when the storage temperature reaches 10 degrees F. The thiamin in dehydrated eggs was found to be not quite as labile as the vitamin A; 90 percent retention could be obtained during one year of storage at 0 degrees F. Riboflavin, niacin, pantothenic acid, and vitamin A are relatively stable in dehydrated eggs stored up to nine months at 0 degrees F, but storage for longer periods results in the rapidly increasing loss of some of these vitamins.

Effect of Cooking and Processing on Cereal and Cereal Products

The substantial nutritive loss that may result from refining of cereal has been reviewed earlier in this discussion. But Lang (110) has reviewed the effect of cooking on nutritive value of cereal and cereal products. Heating wheat at 100 degrees C. was reported actually to improve its nutritional value, but overheating causes a decrease. Home cooking methods cause no deterioration of the nutritive value of corn, but water soluble nutrients can be lost from rice due to leaching into excess amounts of cooking water, which may subsequently be discarded.

Lang also reported that some loss of protein value normally occurs in bread baking. This loss apparently occurs in the crust where the Maillard reaction destroys some of the available lysine. These lysine losses ranged from 9.5 to 23.8 percent and varied with the baking time, the baking temperature, and the loaf size. Amino acid losses due to baking are much greater in breads made with amino-acid-fortified flour than in breads made with unfortified flour. Certain commercial cereal processes that involve severe heat treatment like toasting or "gun explosion," have been reported to cause a large loss of lysine and a general deterioration of nutritive value (110).

According to Kramer (103) flours that are essentially comminuted dry or dehydrated cereal products readily lose nutrients under adverse storage conditions. Both vitamin loss and protein quality deterioration may occur at high storage temperatures. Wheat flour that is not sealed in air-tight containers requires storage temperatures of 38 degrees F. to retain 90 percent of its protein value for six months and still lower temperatures if it is to be held longer. When wheat flour was stored in sealed jars, a full 90 percent of its protein value remained for 12 months at 38 degrees F.

Effect of Cooking on the Nutrient Content of Fats and Oils

Considerable interest in the effects of cooking on the nutritional value and toxicological properties of fats has developed recently. Thermal oxidation of fat occurs during cooking, and this can result in a decrease in the nutritional quality of the fat. Furthermore, the degraded products that result from this oxidation may help destroy other nutrients in food partially composed of fat or in food cooked in fat. According to Lang (110), the amount of thermal fat oxidation that takes place and its ultimate effects depend on such factors as fatty acid composition, time of heating, temperature used, extent of aeration, surface-volume relationships, and presence or absence of pro-or antioxidants. Lang also found that two types of oxidative changes may occur in fat:

> [T]hose that occur when fats or oils are exposed to oxygen at relatively low temperatures, even at room temperature. The principal changes consist in the production of hydroperoxides. [Hydroperoxides destroy vitamins, particularly vitamin A and E, amino acids and other compounds susceptible to oxidation.]
>
> The second group of changes is found in fats or oils heated to higher temperatures exceeding approximately 150 degrees C.

At these temperatures, the hydroperoxides become unstable and numerous secondary compounds are formed.

The polyunsaturated fatty acids are most susceptible to oxidation. One of the major polyunsaturated fatty acids in fats is linoleic acid which is an essential nutrient. Thus, oxidation of the polyunsaturated fatty acids reduces the nutritive value of fat. Kilgore and Bailey (101) studied the degradation of linoleic acid in various fats used for frying. After the fats had been used to fry potatoes for intermittent periods totaling 7.5 hours, the linoleic acid content of safflower oil was reduced by 2.9 percent, that of corn oil 5.5 percent, cotton seed oil 6.5 percent, and shortening 3.5 percent. In a later study, Kilgore and Windham (102) studied the changes in the linoleic acid content of frozen, deep fried potatoes by frying the potatoes in a repeatedly used commercial blend of cottonseed and soybean oil. These potatoes were held in freezer storage for six months and then reheated (a) in oil in a deep fat fryer, (b) in a conventional oven, and (c) in a microwave oven. The last pound of fried potatoes contained less linoleic acid than the first pound fried, regardless of method of heating. The authors felt that

> [T]here seems to be little justification for preferring one method of heating frozen deep-fried potatoes over another, but some consideration should be given to degradation of linoleic acid with repeated use.

Lang (110) has expressed the same opinion: "The saving and re-use of frying oils does not appear to be advisable."

Schiller et al. (137) found that lipids extracted from egg yolk samples heated by both conventional and microwave heating exhibited no change in fatty acid composition and no measurable decrease in polyunsaturated fatty acids. However, the level of oxidized fats in cakes baked in the microwave oven was somewhat higher than that of cakes baked in the electric oven. Thus apparently microwaves do not interact strongly with lipid molecules to initiate hydrolysis or auto-oxidation in food systems.

Unusually severe fat treatment can produce toxic substances in quantities harmful to experimental animals. However, Lang (110) believes that conditions necessary for the formation of such toxic substances are much more severe than those normally encountered in household or industrial food preparation. Lang cites several studies that demonstrate that fat obtained under practical conditions from food manufacturers, restaurants, bakeries, and home cooking operations typically show none of the damages characteristic of overheating by severe laboratory treatments.

Nutritional Value of Food Provided by "Convenience Food Service Systems"

In recent years the food service industry has been relying heavily on "convenience food service systems" where food is partially or completely prepared, then preserved by freezing, canning, refrigeration, or some other process until it is distributed to institutions or restaurants. When these products are served, the nutritive value will depend on (a) the original nutritive value of the raw ingredients in the product and the alteration of that value in preparation, (b) the preservation and storage of the product before its distribution, (c) the method of reconstitution, and (d) the condition under which the reconstituted product was held before serving. La Chance *et al*. (108) point out that food tables like *USDA Handbook No. 8* are of limited usefulness for calculating the nutrient content of products of this sort because nutritional losses in processing, storage, and reconstitution were not considered when the handbooks were compiled. Only limited research has been undertaken to ascertain the final nutritive value of these products, but the development of methods for the nutritive analysis of frozen, fully-cooked institutional foods have already been reported by Garjes and Smith (77). Analyses were developed specifically for protein, crude fat, ash, crude fiber, sodium, potassium, calcium, iron, and phosphorus content. Food Care Division, CPC International, now uses these analyses and provides specification sheets, which include these nutrients analyzed per cooked portion, for each of the pre-cooked frozen meals they supply to hospitals and nursing homes. These analyses sheets will become increasingly helpful to dietitians in calculating such therapeutic diets as low-sodium, or low-fiber diets. No analyses are included for vitamins, however; consequently no estimate of vitamin retention in the pre-cooked meals can be made as yet.

Kahn and Livingston (97) have investigated the effect of heating methods on the thiamin retention in fresh or frozen, prepared beef stew, chicken a la king, shrimp newburg, and peas in cream sauce. The thiamin losses in all of these dishes were greater when the products were freshly prepared and held hot at 180 degrees F. for one, two, or three hours than when the same foods were frozen after preparation, stored at -10 degrees F. and reheated in either a microwave or infrared oven to 194 degrees F. When these frozen products were reheated by immersion in boiling water, their thiamin retention was still greater than in the fresh food held hot, with the single exception of the peas in cream sauce, which exhibited the same thiamin retention in the frozen reheated product and the fresh product held hot for one hour. The authors therefore suggest that the "trend towards 'convenience food service systems' with reliance on central preparation and freezing may indeed offer some incidental nutritional benefits, provided the reheating of foods is carried out by rapid methods."

Fries and Graham (76) compared the vitamin C retention in portions of pre-plated, frozen meals reconstituted with integral or convection heat. The vitamin C loss for the peas and potatoes in these meals, they discovered, was significantly greater when convection heat was used than when the meals were reconstituted with integral heat.

Livingston _et al_. (114) have reported on studies done by the staff of the Catering Research Unit of the University of Leeds. The vitamin C, thiamin, riboflavin, and lysine contents of preprepared foods frozen in bulk and reheated using convection ovens (the "cook-freeze system") were compared with that of conventionally prepared hospital foods. The cook-freeze system retained significantly more vitamin C than the conventional system, but differences in thiamin and riboflavin contents between the two systems were not really significant. The improved lysine retention obtained with the cook-freeze system indicated that it causes less damage to protein quality than the conventional system.

Hoppner _et al_. (94) investigated folacin activity in 30 types of frozen dinners. In terms of total folacin supplied per whole dinner, the dinners supplied from 12 to 79 micrograms of folacin each, which constitutes only a small percentage of the adult RDA of 400 micrograms per day. Total folacin activity was not reduced during reheating of the dinners, but there was an average decrease of 22 percent in free folacin amounts due to the heating. Since free folacin is biologically more available than some of the conjugated forms included in total folacin, this decrease during heating probably indicates a decrease in the overall availability of folacin.

Hellendoorn _et al_. (90) investigated the nutritive value of six types of canned meals. The meals consisted of meat, vegetables, pulses, and potatoes, and the examinations occurred before and after sterilization and after storage for one and one-half, three, and five years. Considerable losses in vitamin A, thiamin , niacin, and pantothenic acid occurred during both sterilization and storage, whereas vitamin E, riboflavin, pyridoxine, vitamin B_{12}, folacin, choline chloride, and inositol were relatively stable. The protein quality of most products decreased slightly during sterilization and declined steadily during storage.

The effect of various methods of heat conditioning and steam table holding on vitamin C and thiamin retention in frozen chicken pot pie was studied by La Chance et al. (108). Varying levels of vitamin C and thiamin were added to pie fillings for this study. The frozen "nutrified" pies were heat-conditioned in convection, conventional electric, and infrared ovens to an internal temperature of 180 degrees F. Samples heated in such a manner were held on a simulated steam table at 180 degrees F. for 30 minutes. Loss in total vitamin C due to heating varied from 9 to 23 percent and in pies containing higher levels of added vitamin C there was less of a loss in convection oven heating than in infrared and conventional oven heating. Covering the samples during heating did not reduce the loss of vitamin C, nor was there any further loss when the samples were held as on a steam table. Thiamin loss average around 30 percent when the pies were heated in conventional ovens and 10 percent when infrared or convection heat was used. Losses of thiamin in samples heated uncovered was 13 percent greater than in the covered samples. Holding samples on the steam table increased thiamin loss by approximately 11 percent.

According to Livingston et al. (114) the nutrient losses resulting from holding hot foods in heated food-warming cabinets are comparable to those that occur during steam table holding. They further report that significant losses of vitamin A and C can occur when hot cooked foods are placed in insulated food carriers in which the heat of the food itself is retained for several hours.

In some modern food systems, prepared items are held chilled for several hours or even days before heating and serving. Studies cited by the Livingston group reveal that vitamins A and C losses in foods held chilled for 72 hours and then heated to serving temperature were considerably lower than losses in food held hot for three hours. However, beef that was chilled for 24 hours, then sliced and reheated to 140 degrees F. showed only a 68-percent thiamin retention, compared to a 79-percent retention in beef held at 140 degrees F. for 90 minutes and then sliced. Slicing and holding the beef exposed more surface area to oxygen, which could account for the greater thiamin loss.

In the "Nacka" or"Delphin" system, prepared foods are filled hot into plastic pouches which are then evacuated, sealed, pasteurized, and chilled until needed. One study reported by Livingston's group examined the effect of this treatment on the vitamin C and thiamin retention of both broccoli in white sauce and chicken a la king. After 4 days, the chilled broccoli retained 28 percent of its vitamin C compared to 41 percent for frozen controls. Chilled chicken a la king retained 84 percent of its thiamin , compared to 77 percent for the frozen controls.

Recent Developments Which May Have An Influence On Nutritional Quality of Meals Served In Mass Feeding Programs

Large segments of the nation's population receive one or more of their daily meals through such mass feeding programs as school breakfast and lunch, congregate feeding for the elderly, the armed services dining, or institutional food service. Obviously, the health of patrons served by mass feeding programs can be significantly affected by the nutritional quality of the meals they receive. Several recent developments in the operation of mass feeding programs are likely to have an impact on the nutritional quality of meals served in these programs. These developments are reviewed below.

New Methods of Menu Planning

Traditional menu planning has used the "food groups" to meet nutritional requirements. (Ahlstrom and Rasanen, 1) In the United States four basic food groups have been established: the milk, meat, fruit and vegetable, and cereal and bread groups. Including specified amounts of these foods in daily meals should provide adequate nutrients. For example, the "Type A" school lunch should provide at least one-third of the recommended daily nutrient intake of a 10- to 12-year-old child, and the food group pattern established to guide in menu planning for such a lunch is

1/2 pint of fluid milk,
2 ounces of meat or an alternate from that group,
2/3 cup of two or more fruits and/or vegetables,
1 serving of enriched or whole grain cereal, and
1 teaspoon butter or fortified margarine.

But Harper and Jansen (87) point out several difficulties inherent in this food-group approach to menu planning:

(a) Individual food items often do not fit into one food group, but are a composite of a number of food groups.

(b) Food groups are only an approximation of the nutrient composition of individual food items.

(c) Fortified or engineered foods are not adequately described by the four food groups.

(d) Food groups do not provide for special dietary needs like sodium, fat, or carbohydrate restrictions.

An alternate approach to menu planning is the "nutrient standard menu" (NSM) method which involves totaling nutrients coming from each menu item to determine whether the totals meet or exceed the desired standards. Harper and Jansen (87) described three NSM techniques which have been developed for testing in mass feeding programs.

The computer method. The digital computer has made possible the development of an automated NSM technique. The Computer-Assisted Menu Planning (CAMP) system has been used in hospitals and is presently being tested in schools. This system combines a large number of precoded recipes to meet a nutrient standard. It offers the ultimate in flexibility, but it requires access to a large digital computer system, thus limiting the application of the technique.

The abacus method. This method requires the development of a specific recipe file and the precalculation of the nutrient composition of each recipe. An experimental method has been developed at Colorado State University which combines the use of precalculated recipes with an abacus-like device to total the nutrients in menus in terms of "bead units." A bead unit for each nutrient is 10 percent of the meal standard for that nutrient. The menu planner must remember that 10 beads are required for each nutrient per meal.

The abacus device has a row of beads corresponding to each nutrient in the standard. Each row is a specific color--protein is brown, vitamin A is yellow, etc. When 10 beads are moved from left to right, the standard for that nutrient is met. Four additional beads per nutrient are allowed to accumulate toward the next day's menu.

The abacus method has been tested nationally in 60 schools in three USDA regions. Jansen and Harper (95) report that the method was found to be fully workable and resulted in "menus nutritionally equal, if not superior, to the Type A menus."

The group method. This method requires the sorting of commonly used menu items into groups having a similar nutrient composition. Between 40 and 100 groups would be needed depending on the purpose of the menu. (General menu planning would require fewer groups than special diet planning.) The menu items in the nutritionally similar groups would form well-defined exchange lists. A computer could search out all feasible combinations to form the exchange lists. Nutritionally equivalent meals which meet the nutrient constraints would then be formed with each menu item (that is, main dish, side dish, etc.) consisting of a list of exchanges. These nutritionally equivalent menus could be published in booklet form, and a menu planner with a thousand of these menus could conceivably plan more than a million specific meals.

Jansen and Harper (95) have pointed out that the use of nutrient standard menu planning in mass feeding programs requires recipes coded according to nutrient composition and that a handbook of nutrient values for foods as processed and served in quantity food systems is also badly needed. This data is not widely available at present and represents a high priority need in institutional food service.

Use of Formulated Nutritionally Modified Foods

Restoration of nutrients in food. Restoring nutrients to foods that have sustained nutrient loss during processing has been practiced in the United States since the early 1940's when restoration of certain B vitamins in cereal products began. The Food and Nutrition Board of the National Academy of Science (74) specifies that nutrient levels achieved through restoration should be from 1.0 to 1.5 times the preprocessed levels.

The enrichment and fortification of food with nutrients. More recently, enrichment and fortification programs have been introduced in which the levels of certain nutrients in foods are raised well above the levels that existed in the preprocessed state. The Food and Nutrition Board endorses the addition of nutrients to foods to achieve enrichment or fortification when all the following conditions are met:

1. The intake of the nutrient(s) is below the desirable levels in the diets of a significant number of people;
2. The food)s) used to supply the nutrient(s) is likely to be consumed in quantities that will make a significant contribution to the diet of the population in need;

3. The addition of the nutrient(s) is not likely to create a dietary imbalance;
4. The nutrient(s) added is stable under customary conditions of storage and use;
5. The nutrient(s) is physiologically available from the food;
6. The enhanced levels attained in the total diet will not be harmfully excessive for those who may employ the foods in varying patterns of use; and
7. The additional cost is reasonable for the extended consumer.

Friend (75) has reported a growing trend to fortify many beverages to levels that will equal or surpass the vitamin C content of orange juice. The addition of vitamin C to fruit juice and drinks more than doubled between 1966 and 1970. Data suggests that a threefold increase in use of vitamin C in flavored beverages and dessert powders occurred between 1967 and 1970. Moreover, the use of vitamin C in such other products as flavored milk extenders and ready-to-eat cereals almost quadrupled in the same time period.

The addition of itamins D and A to foods has also increased. Since 1957, the total amount of vitamin A has more than tripled while its use in milk increased almost nine times. (Friend, 75)

The Federal Food and Drug Administration (71) has recently set a new standard for iron enrichment in flour and bread. This standard would require 40 mg of iron per pound of flour and 25 mg per pound of bread, which doubles the present 12.5 mg limit in bread. The new standard was to become effective April 15, 1974. But it has been delayed until January 1, 1975, pending the outcome of an April 1 hearing when certain objections by individuals and doctors were raised. These objections were summarized in Consumer News (63) as follows:

a. Added iron could created a health hazard for persons suffering from such iron storage disorders as hemochromatosis, sideroblastic anemia, thalassemia, Cooley's anemia, and chronic liver disease associated with excessive consumption of alcoholic beverages;

b. Added iron may mask diagnosis of such other illnesses signaled by anemia as intestinal cancer;

c. Added iron may contribute to the development of Parkinson's disease; and

d. Added iron may cause elevated hematocrit and elevated hemoglobin.

Protein or essential amino acids are being added to certain food products to improve both the quantity and quality of protein. Sidwell and Stillings (139) have studied the use of fish protein concentrate (FPC) to upgrade the nutritional quality (Protein Efficiency Ration, PER) of saltine-type crackers. Fortification levels of only between 4 and 8 percent EPC increased the PER threefold or more, whereas higher fortification did not further improve nutritional quality. Moreover, crackers fortified with the 4 to 8 percent FPC were as acceptable as unfortified crackers in texture and flavor.

Graham (83) evaluated a corn-soy-wheat macaroni containing 21 percent protein. The product was fed to malnourished infants; the researchers found the protein digestability to be close to that of modified cow's milk; and the net protein utilization was approximately 75 percent of that of casein. In tests in Peru, Brazil, and the southern United States, the product was found to be highly acceptable.

In late 1972, the FDA (64) issued a regulation allowing supermarkets to shelve "enriched macaroni products with fortified protein." The regulation requires that the proportion of milled wheat be larger than the proportion of any other ingredient and that the protein content be not less than 20 percent by weight. The new product must be labeled "Enriched Wheat ______________ Macaroni Product--with Fortified Protein," and the blank space must contain the name of the type of flour or meal used, like "soy" or "corn." Protein-fortified enriched macaronies have already been approved for use as a meat alternate in the school lunch program. These macaronies must contain a minimum of 20 percent protein with a PER equal to 95 percent of that of casein (Rosenfeld, 133) and it is allowed to satisfy up to one-half the minimum requirement for two ounces of cooked meat and cheese.

Formulated or "synthetic" foods. Advances in food technology have made it possible to produce a variety of "new foods" which frequently use as a base blended cereal grains, oil seeds, legumes, roots, or tubers as sources of protein and energy. Examples are foods resembling dairy products, fruit juice, and meats in appearance, texture, flavor, and odor. The Food and Nutrition Board of the

National Research Council (74) has stated that "the composition of a new or formulated food becomes especially important when an average serving of the product it imitates or replaces contributes 5 percent or more of the recommended daily allowance of any essential nutrient or energy. The formulated food should contain on a caloric basis at least the variety and the amounts of important nutrients provided by the food it replaces."

Some formulated products have been designed to replace the major part of a meal. Such products according to the Food and Nutrition Board (74) "should provide for those essential nutrients for which RDA allowances have not been established, 25 to 50 percent of the estimated requirement. Caloric value of such products depends upon recommended use."

Baker _et_ _al_. (45) have summarized the market penetration by substitute and "synthetic" foods. For example, substitutes for dairy products abound. Margarine accounts for more than two-thirds of the table spread market; nondairy coffee whiteners comprise about 35 percent of the light cream market; and substitute toppings have more than half the whipped topping market. Total sales of filled milk amount to only a fraction of one percent of United States sales of fluid whole milk, but Baker's group predicts that these substitutes will increase their market share as more acceptable products are developed.

Formulated substitutes for citrus juices are available in cans, bottles, and cartons in liquid, frozen, or powdered form. These products now account for about 21 percent of the 600-million-gallon [illegible] retail citrus beverage market (45).

Adverse publicity over animal fat in the diet and the lower cost of vegetable protein compared to meat protein have provided a genuine incentive to develop protein foods to replace meat (45). Soybean protein increasingly substitutes for meat. Some soy products are used as partial substitues of "meat extenders," while other products are formulated to replace meat as meat analogs. The extenders are more widely used probably because other plant products like oatmeal and bread crumbs have traditionally been used to extend meat in numerous recipes: meat "extension," in other words, is already a familiar technique.

Some institutions facing fixed budgets are using soy-based meat substitutes because they reduce the cost of meals. In 1971, the U.S. Department of Agriculture allowed the use of textured vegetable protein (soy protein is used most widely) as a meat extender in the school lunch program. Hekman (89) has reviewed the specifications set up by USDA for this use of textured vegetable protein: The vegetable protein product can be prepared and served in combination with ground or diced meat in the form of meat patties, meat loaves, or meat stews, or in similar foods made with poultry or fish. The ratio of 30 parts hydrated vegetable protein (with a moisture content of from 60 to 65 percent) to 70 parts uncooked meat, poultry, or fish has been established. The textured vegetable protein product can be made from food grade oil seed or cereal flours or can be derived from protein concentrate or isolates. The protein efficiency ratio (PER) of the textured vegetable protein cannot be less than 1.8 on the basis of PER = 2.5

for casein. The PER of a meat-textured vegetable protein combination can not be less than 2.5

The extensive use of textured vegetable protein products in school lunch occasions some caution. Murphy (123) points out that the vegetable protein products made according to the school lunch specifications are inferior to poultry, fish, milk, and eggs in nutrient quality, and "They do not have the same ideal balance of essential amino acids; they do not have all of the minerals and other micronutrients; and they do not have the same level of nutrient availability." Murphy calls textured protein products "satisfactory protein supplements" but "not adequate substitutes for meat, fish, poultry or eggs in the school lunch programs."

Clausi (57) has summarized the technological problems that the food industry faces in formulation and nutritional modification of food in the following five questions:

(a) Where will we obtain the new knowledge we need on micronutrients and trace substances?

(b) Where will we find the low-cost sources of protein that have a wide range of functional characteristics and a high nutritional rating?

(c) How soon will we solve the problems of taste, product performance, processing, and so on, that some nutrients are currently giving us?

(d) How will we solve the problem of storage life of nutritionally modified products and the variability of natural sources? Old data will not necessarily apply.

(e) How will we make sure that the nutrients we put into modified foods are biologically active when they are consumed?

Central Commissaries and Contract Service

Central commissaries. A type of system which is currently finding increasing use in mass feeding programs is the central commissary. According to O'Hara *et al*. (128) the central commissary consists of a "central food storage facility and a food manufacturing plant which provides food in various states of preparation for service at satellite locations." Usually the central commissary is physically removed from the location served so that a certain time exists between preparation and service. This time gap necessitates the preservation of cooked foods either by chilling or freezing, the transportation of them to serving locations, or reheating. The distance between the commissary and satellite location may vary from a few to almost a hundred miles. The central commissary approach is presently in use in many school lunch programs, institutions, and restaurants.

Contract service. In recent years increasing numbers of institutions and restaurants have contracted with outside commercial firms for food service, and in 1970 the decision was made by the U.S. Department of Agriculture to allow schools to contract food service without losing federal subsidies.

Three types of contract services have been described (11):

1. The operating contract--In this type the management company sends its own personnel into a school system's kitchen and cafeteria to run them. In a few cases, only management supervision is furnished by the contractor.

2. The preplated food system--In this type frozen, preplated meals are furnished by the food manufacturer. These are heated and served by school personnel who are also responsible for milk, dessert, and other extras.
3. The prepackaged food system--In this type the meals are assembled at a central kitchen with all necessary hot and cold menu items included. Children are usually served by school personnel. Such a system is the same as the central commissary with the commissary being owned and operated by a commercial firm.

Effect of central commissary and/or contract service on the nutritional quality of meals. In most cases, food prepared by contract or in central commissaries is subjected to a preservation period and reheating step. But this is not the case with "on site" prepared food. Sufficient research has not yet been done to assess the effect of this type of handling on the final nutritive quality of food. But Miskimin *et al.* (122) calculated the nutritive value of 156 frozen preplated Type A school lunches furnished by three nationally known companies. They found that the calculated levels of calcium, calories, thiamin, and iron would not assure the expected one-third RDA levels. The authors express the belief that these results derived from values in Handbook No. 8 probably overestimate the nutrient values that would actually be found by chemical analysis.

Studies which involved analytical determinations of the nutritive value of commissary type meals are limited. These were reviewed in Section Two of this report, and they should constitute research of a high priority.

Nutrient Labeling Regulations and Initial Reactions to Them

Introduction

One of the major recommendations that emerged from the 1969 White House Conference on Food, Nutrition and Health was that nutritional labeling be included with food products. An ad hoc nutritional labeling advisory committee composed of nutrition experts, educators, and representatives of consumer groups, government, and industry began work in early 1970 to devise an easy-to-understand nutritional labeling system. The Journal of Home Economics (17) reviewed the pilot studies that were conducted on the three alternative formats derived for conveying the amounts of nutrients provided by a serving of a particular food. These included

1. Numerically, by percent or unit;
2. Verbally, through use of adjectives; and
3. Pictorially, through use of stars, circles, or other symbols.

Five large food chains cooperated with the FDA by introducing experimental nutritional labeling in their stores. They were the Consumer Cooperative of Berkeley, Inc.; First National Stores; Giant Food, Inc.; the Kroger Company; and Jewel Food Stores.

Nutrient Labeling Regulations

In January of 1973 the FDA published the first phase of a comprehensive program to regulate labeling in regard to nutrient content of food in The Federal Register (72). The second and third phases were published in the March 14 and August 2 issues of the 1973 Federal Register. Excellent summaries of all three phases of this program have been published in Nutrition Reviews (28, 29, 30).

According to FDA the new program is "designed to provide the American consumer with specific and meaningful new information on identity, quality and nutritional value of a wide variety of general and special foods available in the nation's marketplace."

FDA Commissioner Charles C. Edward said that the actions will result in "the most significant change in food labeling practices since food labeling began," and that the regulations "will put into practice virtually all of the labeling recommendations of the White House Conference on Food, Nutrition, and Health." This labeling program includes regulations governing when and how nutritional labeling is to be used, a uniform format to be used on labels, provision for the identification of the fat and cholesterol content of food, standards for products sold as dietary vitamin and mineral supplements, and new rules for the definition and labeling of imitation and artificially flavored foods.

When shall nutrition labeling be used? Nutritional labeling is voluntary for most foods, however if a product is fortified by the addition of a nutrient, or if a nutritional claim is made or nutrition information given in its labeling or advertising, that product must have full nutrition labeling. Any reference to the protein, fat, carbohydrate, calories, vitamin, or mineral content of a product, or any statement concerning the use of that product in dieting will trigger full nutrition labeling. A food cannot be called a "significant source" of a nutrient unless that nutrient is present in the food at a level equal to or in excess of 10 percent of the US-RDA per serving. Furthermore, no claim of nutritional superiority to another food may be made unless the food contains 10 percent more of the US-RDA of the claimed nutrient per serving. Statements concerning the cholesterol or sodium content of a food will be permitted without invoking full nutritional labeling.

The regulation specifically sets forth five prohibitions in regard to claims that can be made about food. Claims cannot be made

1. That a food, because of the presence or absence of certain dietary properties, is adequate or effective in the prevention, cure, mitigation, or treatment of any disease or symptom.
2. That a diet of ordinary foods cannot supply adequate amounts of nutrients.
3. That the lack of optimum nutritive quality of a food, by reason of the soil on which that food is grown, is or may be responsible for an inadequacy or deficiency in the quality of the daily diet.
4. That the storage, transportation, processing, or cooking of a food is or may be responsible for an inadequacy or deficiency in the quality of diets.
5. That the food has dietary properties when such properties are of no significant value or need in human nutrition.
6. That a natural vitamin in a food is superior to an added or synthetic vitamin, or [that there is a difference] between vitamins naturally present and those [that are] added.

All labeling ordered after December 31, 1973, and all products shipped after December 31, 1974, shall be in compliance with these new regulations.

How shall nutritional information be presented? Levels of vitamins and minerals will be listed as a percentage of the newly established "U.S. Recommended Daily Allowance" (US-RDA) which replaces the previously used Minimal Daily Requirements (MDR). The US-RDA values were derived from the highest value for each nutrient given in the National Academy of Science-National Research Council tables for males and nonpregnant, nonlactating females, four or more years of age except for calcium, phosphorous, biotin, pantothenic acid, copper, and zinc. The US-RDA for calcium and phosphorus (both one gram) are not the highest values in the NAS-NRC tables (both 1.4 grams) because of their physical bulk and solubility, the wide variability in requirements depending on age, the human requirements of one gram generally accepted in the U.S., and the lower values generally advocated by international nutrition groups. The US-RDA values for biotin, pantothenic acid, copper, and zinc had not been tabulated when the nutrient labeling regulations were being drawn up, however, all these are recognized as essential in human nutrition so US-RDA values were established so that these could be included in nutritional information on labels. The US-RDA for vitamins and minerals are shown in Table 1.

A value of 45 grams was selected as the US-RDA for protein having a protein efficiency ratio (PER) value equal to or greater than that of casein. A value of 65 grams of total protein was set

TABLE 1

UNITED STATES RECOMMENDED DAILY ALLOWANCES

VITAMIN OR MINERAL	UNIT OF MEASUREMENT	INFANTS AND CHILDREN UNDER 4	ADULTS	PREGNANT OR LACTATING WOMEN
Vitamin A	IU	2,500	5,000	8,000
Vitamin D	IU	400	400	400
Vitamin E	IU	10	30	30
Vitamin C	mg.	40	60	60
folic acid	mg.	0.2	0.4	0.8
thiamin	mg.	0.7	1.5	1.7
riboflavin	mg.	0.8	1.7	2.0
niacin	mg.	9.0	20	20
Vitamin B_6	mg.	0.7	2.0	2.5
Vitamin B_{12}	mc.	3.	6.	8.
biotin	mg.	0.15	0.3	0.3
pantothenic acid	mg.	5.0	10	10
calcium	gm.	0.8	1.0	1.3
phosphorous	gm.	0.8	1.0	1.3
iodine	mc.	70	150	150
iron	mg.	10	18	18
magnesium	mg.	200	400	450
copper	mg.	1.0	2.0	2.0
zinc	mg.	8.0	15	15

as the US-RDA for protein, having a PER value less than that of casein. Total protein having a PER value less than 20 percent of that of casein cannot be stated on the label in terms of percent US-RDA; it must be designated as "not a significant source of protein."

The standard format shown in Table 2 is required in its entirety whenever nutritional labeling is used.

TABLE 2

Nutrition Information

- Serving Size
- Servings per container
- Caloric content
- Protein content in grams
- Carbohydrate content in grams
- Fat content in grams

Percentage of U.S. Recommended Daily Allowances (US-RDA) of protein, vitamins and minerals

- Protein
- Vitamin A
- Vitamin C
- Thiamin
- Riboflavin
- Niacin
- Calcium
- Iron

A listing of all seven of the vitamins and minerals shown in Table 2 must be included if the food contains 2 percent or more of the US-RDA for these vitamins and minerals. However, if a food contains less than 2 percent of the US-RDA for four or more of these seven nutrients, the manufacturer may choose to list only those present at more than 2 percent of the US-RDA with an appropriate disclaimer for the nutrients not listed.

An example of a label bearing such a disclaimer is shown in Table 3. If a product contains more than 2 percent of vitamins and minerals other than the major seven listed in Table 2, the manufacturer has the option of also including these other vitamins and minerals on the label of the product.

If a food is combined with another ingredient before eating and directions for such combinations are provided, nutrient content for the final combination may also be listed. An example of such a label is also shown in Table 3.

Labeling for cholesterol, fat and fatty acids. The need for information concerning the cholesterol, fat, and fatty acid composition of food was considered in light of the relationship these may have to coronary heart disease. Regulations will permit

1. A statement on the label of the cholesterol content in milligrams per serving;
2. A list on the label of the amounts of polyunsaturated fatty acids, saturated fatty acids, and other fatty acids in grams per serving; and
3. A statement on the label concerning the total fat content as a precentage of the calories in the food.

If any of this information is provided, the label must also include this statement:

Information on fat and/or cholesterol content is provided for individuals who, on the advice of a physician, are modifying their total dietary intake of fat and/or cholesterol.

TABLE 3

Examples of Labels

Label bearing a disclaimer	Label showing nutrient content after the food has been combined with another ingredient

Label bearing a disclaimer

Nutrition Information

serving size = 1 oz.
servings per container = 10

Caloric content	100
Protein content	24 grams
Carbohydrate content ..	5 grams
Fat content	1 gram

Percentage of US Recommended Daily Allowances (US-RDA)* of protein, vitamins, and minerals

Protein	3
Thiamine	5
Niacin	5
Iron	2

*Contains less than 2% of US-RDA of Vitamin A, Vitamin C, riboflavin and calcium

Label showing nutrient content after the food has been combined with another ingredient

Nutrition Information

serving size: One ounce (1 cup) of Zest cereal and in combination with 1/2 cup Vitamin D fortified whole milk

Servings per container: 10

Zest Cereal

	1 oz.	with 1/2 cup whole milk
Calories	110	190
Protein	2 gm	6 gm
Carbohydrate	24 gm	29 gm
Fat	0 gm	4 gm

Percentage of U.S. Recommended Dietary Allowance (US-RDA)

	1 oz.	with 1/2 cup whole milk
Protein	2	10
Vitamin A	20	20
Vitamin C	20	20
Thiamin	20	20
Riboflavin	20	35
Niacin	20	20
Calcium	5	20
Iron	10	10
Vitamin D	10	25

However, no label may contain a claim suggesting that the product will prevent, mitigate, or cure heart or artery disease or any attendant condition.

Dietary supplements and foods for special dietary use. Now included as dietary supplments are

(a) any vitamin and/or mineral prepared as tablets, capsules, or liquid that contains from 50 to 150 percent of the US-RDA per dose. (In the case of vitamin A and D, the range is 50 to 100 percent of the US-RDA), and

(b) any physical form of conventional foods to which any mineral or vitamin has been added to the level of 50 percent or more of the US-RDA per serving of that nutrient.

A food that falls in the category of a dietary supplement must comply both with provisions established for dietary supplements and with nutritional labeling requirements. The label must bear the common name of the product plus a statement of the group (infants, children, adults, or pregnant/lactating women) for which it is intended. The list of the nutrients must also be included on the label along with the percentage of the US-RDA and the natural chemical form of each nutrient present. If the product is subject to deterioration, an expiration date must be given.

Excluded from the category of dietary supplements are

1. Foods, with a composition defined by other statutes or regulations;
2. Any food represented for use as the sole item of a meal

or of the diet;

3. Foods used under medical supervision;
4. Fabricated or conventional food to which nutrients are added to a level of less than 50 percent of the US-RDA per serving;
5. Raw agricultural commodities; and
6. Foods with nutrients restored to preprocessing levels or added so that they are not nutritionally inferior to the food for which it substitutes and resembles.

Foods meant for "special dietary use" refer to those which are meant to be used in one or more of the following ways:

1. To supply a special dietary need that exists by reason of a physical, physiological, or other condition such as convalescence, pregnancy, lactation, allergic hypersensitivity, diabetes; or a need to control sodium intake;
2. To supply a vitamin, mineral, or dietary property to supplement the diet, except for foods for which nutrition labeling is used; or
3. To supply a special dietary need by reason of being a food for use as the sole item of the diet.

It is clear then that these regulations draw a clear distinction between ordinary foods and special dietary food meant for diet supplementation. In general, if a food contains less than 50 percent of the US-RDA it is an ordinary food. If it contains from 50 to 150 percent of the US-RDA , it is a dietary supplement. Further regulations have been established which specify that foods to which nutrients have been added to exceed 150 percent of the US-RDA's must be labeled and marketed as drugs.

Compliance with label statements. Nutrients in food are divided generally into two classes for compliance purposes:

Class I--Added nutrients in fortified or fabricated foods,

Class II--Naturally occuring (indigenous) nutrients.

The nutrient content of Class I foods must be at least equal to the value of the nutrients declared on the label, whereas, the nutrient content of Class II foods must be equal to at least 80 percent of the declared value. In the case of calories and fats, the product values cannot be more than 20 percent above the value appearing on the label.

New regulations for the definition and identification of imitation foods and food flavorings and spices. The White House Conference on Food, Nutrition and Health recommended that "oversimplification and inaccurate terms such as 'imitation' should be abandoned as uninformative to the public." In response to this, a regulation now requires the use of "imitation" only when a food is nutritionally inferior to the imitated food product. Nutritional inferiority is defined by the FDA as any reduction in the content of an essential nutrient that is present in the food resembled at a level of 2 percent or more of the US-RDA per serving. Reduction in caloric or fat content does not constitute nutritional inferiority. A product which is similar to an established food and at least nutritionally equivalent to that product must bear a new common or usual name or an appropriately descriptive term, and it must comply with nutritional labeling regulations. The first standards of identity under the "Imitation Foods" regulation are being established for two frozen desserts that will be sold under the name "mellorine" and "parevine" with no reference on the label to either "ice cream" or "imitation."

The purpose of the new regulation on food flavorings and spices is to clarify FDA's policy and to develop a labeling pattern for flavorings in food that will provide consumers with clear, consistent information. This will be accomplished by establishing two major classes of flavored foods. Foods containing any amount of artificial flavor shall be labeled with the name of the food accompanied by the common or unusual name of the characterizing flavor preceded by the words "artificial" or "artificially flavored." The other class of foods consists of those that contain no artificial flavor, and the name of those foods shall be accompanied only by the common or usual name of the characterizing flavor. This new provision applies to all products including standardized foods.

Guidelines for "frozen dinners" or "heat and serve main dishes" and non-carbonated beverage products which contain no fruit or vegetable juice. The new regulations which serve as guidelines for the composition of "frozen dinners" state that these dinners

a. shall contain at least three components, one of which shall be a significant source of protein and each of which shall consist of one or more of the following: meat, poultry, fish, cheese, eggs, vegetables, fruit, potatoes, rice, or other cereal-based products other than bread or rolls. The product may, however, contain other servings of food (like soup, bread or rolls, a beverage, or dessert).

b. shall be labeled with "frozen heat and serve dinner," except that the name of the predominant characterizing ingredient may immediately precede the word "dinner" (as in "frozen chicken dinner"). The words "heat and serve" are optional as is the word "frozen" provided that the words "keep frozen" or the equivalent are used in a prominent place on the package. The label must also accurately list the other ingredients included in the dinner in order of descending predominance by weight. If a vignette appears on the package depicting foods which are not included, the label must bear a prominent statement that such servings are not present.

Nutritional quality guidelines for such dinners have been established as shown in Table 4, but compliance with these nutritional guidelines is not required of those products using the name "frozen" or "heat and serve" dinners. Those products that do meet such guidelines--and only those--may bear the statement "This product provides nutrients in amounts appropriate for this class of food as determined by the United States Government."

TABLE 4

Minimum Levels of Nutrients for Frozen "Heat and Serve" Dinners

Nutrient	For Each 100 Calories (kcal) of the Total Components	For the Total Components
Protein, grams	4.6	16
Vitamin A, IU	150	520
Thiamin, mg	.05	.2
Riboflavin, mg	.06	.2
Niacin, mg	.99	3.4
Pantothenic Acid, mg	.32	1.1
Vitamin B_6, mg	.15	.5
Vitamin B_{12}, mcg	.33	1.1
Iron, mg	.62	2.2

"Heat and Serve" main dishes are classified as convenience products that offer some ingredients needed for the main dish but require that some important, characterizing ingredients be added. The regulations regarding these products are meant to avoid confusing the consumer--that is to make it clear that the main ingredient is not in the package. The label of these products must include the common or usual name of each important component in descending order of predominance by weight, and informative statement identifying the food to be prepared, and a statement listing the additional ingredients that must be added. If any vignette on the package shows food not included, a statement must appear specifying that the food shown is not contained in the package.

Non-carbonated beverage products which contain no fruit or vegetable juice include dehydrated or powdered items. They must bear a descriptive name and a statement of lack of juice if the label color, or flavor of such beverages represents, suggests, or implies that any fruit or vegetable may be present.

Proposed labeling regulations for restructured foods. These proposed regulations would establish distinctive common or usual names for certain packaged foods that appear to be traditional foods but are manufactured by a new process. Examples of such foods are "onion rings" made from fresh chopped onions that have been pressed into the shape of a ring or "potato chips" made from dehydrated potatoes formed into the shape of potato chips. Under the proposal the following names would be established for the various restructured foods:

a. "Onion Rings Made from Diced Onions"

b. "Fish Sticks (or portions) Made from Minced Fish"

c. "Fried Clams Made from Minced Clams"

d. "Breaded Shrimp Sticks (or cutlets) Made from Minced Shrimp"

e. "Potato Chips Made from Dehydrated Potatoes."

These names would have to appear on the package labels.

Reactions to Nutritional Labeling

During the period when the nutritive labeling regulations were being established Ogden C. Johnson, Director of the FDA's Division of Nutrition (180), stated that

> Nutrition labeling provides a standardized means of marketing one of the most valuable aspects of grocery products--their nutrition qualities--to the consumer.

> It also provides a way of showing the consumer that industry is interested in providing the services they want. . . . Implicit in this opportunity is a challenge--to motivate the consumer to become educated enough to read and appreciate nutritive properties. There is also an explicit challenge in this opportunity--to provide meaningful, accurate data to the consumer.

The extent to which these opportunities and challenges are realized will depend upon the reaction of the consumer and food industry to nutrition labeling. Will the consumer use the information? Will it affect his selection of food? Will the industry see the regulations as opportunities rather than restrictions? It is far too early to answer these questions with any certainty. A few surveys of consumer reaction to nutrition labeling were conducted along with various pilot studies of the labeling program. Some reaction from the food industry has been reported, and these surveys and reports serve as an initial assessment of consumer and industry reaction to nutritional labeling. But thorough assessment can be obtained only after the program has been fully implemented.

Consumer reaction. The Consumer Research Institute (151) was involved in several research projects on the nutrient labeling of foods for three years (1969-1972), and much of its research was coordinated with the Food and Drug Administration. Results of a CRI 1969 survey of 2,186 women revealed that 64.6 percent occasionally looked for nutritional information on packaged food products. Those who look for such information are more apt to be white, educated, affluent segments of the society living in suburban or metropolitan areas. The consumers' order of interest priorities in ingredient information was found to be first, vitamins and minerals; second, calories; and third, proteins, fats and carbohydrates.

CRI also conducted an experiment in which the food purchases of 923 families were carefully recorded for a four-week period during which no nutrient information was available followed by an eight-week test period during which nutrient information was provided. The results of this experiment were encouraging. More nutritious products were purchased after the consumers were exposed to nutrition information. However, these consumers belonged to the middle and upper socio-economic levels and considerable effort had been made to motivate them to use nutrient information.

A research team headed by R. J. Lenahan at Cornell University (111) reported on a survey conducted among 2,195 men and women aged 18 years and older during the period of March 15 through April 8, 1972. This group comprised a statistically representative sample of the U.S. population based on government census data. Results showed that 58 percent favored using nutritional labeling to some extent. However, actual use of the labels was low--about 10 percent of all the respondents used the information, but the use increased with the length of time the program was in effect.

The number of persons in the 18 to 49 age groups who said that they would use the labels extensively was significantly larger than the number of respondents in the group 60 years or older who gave this response. Education was directly related to the number of persons who said that they would use the labels; as the amount of education increased, indications of potential use increased. Finally, the number of persons who said they would use the labels was significantly larger among the white, than among the non-white respondents.

Respondents were asked about the amount of money they would be willing to pay for nutrition information since the cost of such labeling information will undoubtedly be passed on to the consumer. The younger, more highly educated were the most willing to pay for the information. Based on a $25.00 grocery bill, 51 percent of the respondents were not willing to pay; 27 percent were willing to pay an insignificant amount (3 cents or less); 13 percent were willing to pay moderately (4 to 10 cents); and 4 percent were willing to pay more than 10 cents for the nutritional labels.

The recognition of nonuse benefits of nutrition labeling was widespread. In response to a "nonleading" question, 30 percent of those interviewed said that consumers would benefit even if they did not use the labels. In answering a leading question concerning nonuse benefits, 85 percent agreed with statements concerning such benefits. The three statements most often chosen follow:

1. The public would learn more about nutrition,
2. Food manufacturers would tend to make their products more nutritious, and
3. Consumers would get better value for their food dollars.

Various promotional programs were found to make consumers more aware of the nutrition labels, but they did not increase the use or understanding of the labels. These two parameters, understanding and use, however, increased as the program ran. The results indicate that exposure over time and promotional intensity have complementary results.

In a test conducted in June and July of 1972 in two urban areas of New Jersey, Babcock and Murphy (44) found that 84 percent of the shoppers were interested in having some nutritional information on labels of all foods, but 41 percent said that the FDA labels were confusing. (The addition of FDA labels increased the sales of more nutritious items only 3 percent during the test period.)

Evaluation of nutritional labeling was carried out as a part of the Spring 1972 Consumer Preference Panels, sponsored by the Marketing Information for Consumer Program of the Cooperative Extension Service at Michigan State University (185). In summarizing the findings of the evaluation, Mary D. Zehner stated,

> No system of nutritional labeling is going to be understood by a majority of the consumers unless there is an extensive educational program to support it. Consumer programs much simpler to understand than nutritional labeling, such as unit pricing and open dating of foods, are only being used on a limited basis, even after promotional programs. But, like open dating and unit pricing of foods, consumers appear to want nutritional labeling. Research studies indicate that understanding and use of nutritional labeling will increase as people become aware of it. However for consumers to get the maximum amount of benefit, they must be willing to take the time to study and understand not only the label, but other nutritional information available to them.
>
> Nutritional labeling as it is presently proposed will not meet the expectations of many consumers. It would appear from the comments and observations that nutritional labeling means different things to different people. The program is more detailed than many panelists visualized it. I would estimate close to one-quarter of the panelists who indicated interest in nutritional labeling are primarily or exclusively interested in simply a listing of calories.
>
> Educational programs need to be developed which will familiarize consumers with nutritional labeling--what it is, what it does not include, and how it can be used in planning

> nutritionally balanced meals and snacks. Nutritional labeling can be a useful aid to all shoppers, even if they are not on a special diet or feel they understand the basics of nutrition. An awareness of the nutrient content of some of the newer combination foods and fabricated foods can be helpful in meal planning and in stretching the food dollar. Also special attention should be directed at an exploration of grams, complete and incomplete proteins, and recommended dietary allowances versus minimum daily requirements. These areas need clarification as a part of the overall education program if consumers are to effectively use nutritional labeling once it is available.

Food industry reaction. Dr. Ira I. Somers, Executive Vice President of the National Canners Association (150) has pointed out that nutritional labeling has created more interest than any of the labeling proposals from the government, Congress, consumers, or trade industry. Of immediate concern to the food industry is the question of what to put on labels in terms of nutrient values. Furthermore, the industry considers the compliance regulation "too restrictive when it calls for each individual unit in the lot to bear a nutrient level at least [illegible] percent of the declared value. To do this is totally unrealistic for many products, and will create serious problems."

Dr. Somers asked the questions "What is 'accuracy'? Would a statement of the average amount of the nutrient the consumer receives over a reasonable period of time be considered accurate labeling? Or, must the nutrient content be grossly understated so that most packages exceed the declaration as suggested by the proposal?" As an illustration of the problem, Dr. Somers provided the following examples:

> The National Canners Association laboratories have shown that the Vitamin C content of 130 samples of tomato juice from the 1969 pack may vary from 1.8 to 45.5 mg per 6-ounce can. This is an average of 24.1 mg per can or 40 percent of the RDA. However, the content that can be

> declared on the label is only 2.2 mg or 5 percent of the RDA if the appropriate statistical adjustment is made to guarantee that each can will contain 80 percent of that declared on the label.
>
> It was pointed out that some of the low values could be the result of poor manufacturing practices which should be corrected but even so, considerable variations occur as a result of conditions beyond the control of the manufacturer. Examples of such variations include seasonal, genetic differences, or whether a plant is grown under shady or sunny conditions.

Dr. Somers concluded by calling into question the objective of nutrient labeling.

> What is the real objective of nutrient labeling? In its broadest aspect its primary value will be as an educational effort designed to provide sound information on the nutritive properties of foods. It seems to us that this objective would be more adequately met by declaring the average values of the nutrients contained in the product at the time it is made available to the consumer. We do not believe that industry would be properly informing consumers of the nutritive properties of food if it had to grossly understate their nutrient content, any more than they would be properly informing consumers by making exaggerated claims.

A report in Consumers' Research Magazine (41) indicates that the far-reaching nutrition labeling regulations which hold food processors responsible for the accuracy of the declaration on the label have brought adverse criticism from a wide variety of sources. The United Fresh Fruit and Vegetable Association, together with Sunkist Growers of California are reported by Consumer Research Magazine to be taking legal steps to seek modification of the labeling regulations, which are asserted to be so restrictive that growers and distributors of fresh fruits and vegetables will be hampered in advertising established nutritional value of their particular products. The United Fresh Fruit and Vegetable Association claims that an advertiser will be barred from indicating that oranges are a good source of vitamin C unless a complete nutritional analysis is provided in the form prescribed by FDA and to a degree of accuracy almost impossible to achieve, owing to well-known variations in the vitamin value of natural produce. This same group claims that the provision of analytical data on the exact content of individual lots of raw, unprocessed agricultural products would be difficult and almost prohibitively expensive.

Some manufacturers believe that the new labeling regulations would boost the retail price of foods and the Consumer Research report pointed out that this would certainly be true at first, although the overhead of the cost of labeling would probably be absorbed in the course of time. Neil Mermelstein (121), associate editor of Food Technology Journal (121) quoted Dr. Virgil O. Wodicka, Director of the FDA's Bureau of Foods, on the question of the cost of nutrition labeling,

> This is another form of the traditional question, 'How high is up?' How much effort it takes to get there depends on where you start. Joining this club may have a rather substantial initiation fee, but the dues are not bad. After you know something about the nutritive value of your product, and its variability, and what affects it, the rest of it is quite manageable from a cost standpoint, and I'd say . . . it would be less than a cent a case.

A number of independent laboratories perform analytical services for food companies. A survey (121) of these laboratories revealed that the cost of determining the content of the nutrients which must be included in the standard nutrient format ranges from $150 to $179 per sample. A sample consists of "12 sub-samples (consumer units), taken one from each of 12 different randomly chosen shipping cases, to be representative of a lot." Of course many large companies may already be equipped for nutrient analysis but many smaller companies probably are not.

Business Week (9) reported in March of 1973 that the Del Monte Corporation was about to start labeling the nutritional content of 34 major products that make up more than half of the company's canned food volume. Before the 1974 packing season gets under way, Del Monte plans to have 120 basic items relabeled. Business Week further states that "though most of FDA's new 12-part standards are voluntary, consumer pressures and competition are almost certain to make them mandatory. As one leading food industry member puts it: 'We are entering the era of the marketing of nutrition.'"

Three Areas for Future Research

1. High priority should be given to determination of the final nutrient value of foods subjected to the various preparation and holding methods used in commissary food service systems. Some of the practices may produce foods of a higher nutritive quality than those produced by conventional methods in which food is held on steam tables for long periods.

2. The industry should develop large files of standardized recipes coded according to nutrient content if the Nutrient Standard Menu methods are to be used successfully. Further study is needed to determine whether menus developed by the nutrient standard methods have acceptable palatability.

3. The inclusion of nutrient information on menus or in fast food restaurants may be desirable. Pilot studies could ascertain the feasibility of this practice and whether patrons would understand and use the information enough to justify the practice.

Nutrition as it Affects
And Will Affect Food Service:
An Annotated Bibliography

1. Ahlstrom, Antti and Leena Rasanen. "Review of Food Grouping Systems in Nutrition Education." Journal of Nutrition Education, 5 (January-March, 1973), pp. 13-17.

   This article compares the food grouping systems of 47 different countries and concludes that for food groups to be a successful tool in nutrition education, local nutritional problems, availability of foods, and food habits must be taken into account. The increase in processed food and convenience food product use suggests that perhaps the entire grouping system should be re-evaluated.

2. James Albrecht. "What About Chemicals in Food?" Fast Food, 71 (March, 1972), pp. 14, 18, 23.

   Albrecht offers questions and answers about chemical processing's effect on nutrition, the importance of food chemicals, synthetic vitamins, the origin of food chemical additives, safety of additives, cost and time in developing safe food additives, and the future of chemical food processing.

3. R. B. Alfin-Slater. "Communicating With the Consumer: Basic Research on Nutrition and Safety; Special Report: Part III." Food Product Development, 6 (August and September, 1972), pp. 66-68.

   This article discusses the synthetic food additives which manufacturers insist are necessary to supply the public with the convenience foods they demand, and which consumer groups feel are unsafe, hazardous, and insufficiently tested. The author describes various studies done in this area.

4. Anon. "Buyer's Bulletin." Institutions, 64 (April, 1969), p. 16.

Two new ready-to-serve, individually packed, low-sodium soups have been introduced by the Campbell Soup Company, adding to the four other low-sodium soups already distributed by that company.

5. Anon. "Buyer's Bulletin." Institutions, 66 (October, 1969), p. 226.

Diet orange and diet cherry gelatin desserts, salt-and sugar-free, are now available on the market. They contain only one calorie per four-ounce serving.

6. Anon. "Calorie Counter." Institutions 65 (September, 1969), p. 130.

Products on the market designed to cut calories include no-sugar soft drink mixes, condiment packets for special diets, non-dairy coffee creamer, sugarless chewing gum, and diet frozen entrees.

7. Anon. "Candor and Comment." American Restaurant Hospitality, 54 (January, 1970) p. 6.

Food items that look and taste like common foods, but are nutritionally richer--orange juice without citric acid, eggs with little cholesterol, potato products with less carbohydrate and more protein--all receive consideration. Foods will soon be especially designed for older people.

8. Anon. "Consumer and Food Industry Equally Responsible for Poor Nutrition." Food Product Development, 6 (November, 1972), p. 11.

The blame for poor nutritional habits must rest, in part, with the consumer and the kind of foods which he demands on the market. Nutritional inadequacy is caused by poverty, negative social, cultural, and religious factors, lack of food fortification, lack of nutrition education, and lack of motivation for correct eating.

9. Anon. "Del Monte Living with New Labeling Rules." Business Week (February 3, 1973), pp. 42-45.

Business Week offers a description of Del Monte's efforts to reorganize their production and marketing approach to meet the challenges of growth, spiraling costs, declines in profitability, and the changing nature of the market. As a part of the new approach, Del Monte will label the nutritional content of 34 major products that make up more than half of the company's canned-food volume.

10. Anon. "Development Aids: Flavored, Colored Apple Pieces Offer Route of Distinction: School Lunch Entree Formulations Offered." Food Product Development, 5 (December/January, 1972), pp. 68-70.

These brief reports advertize two new food items aimed at school lunches: "vacu-dry apple nuggets and dices are processed apples colored and flavored to imitate blueberries and raspberries; "ultra-soy" is a TVP.

11. Anon. "Digesting the Alternatives." Nation's Schools, 88 (September, 1971), pp. 63-67.

Commercial food management firms are making small inroads into school feeding programs, mainly in large urban school districts. The federal government is expected to increase governmental involvement in school food operations with the passage of bills to provide free school lunch and feeding for the elderly.

12. Anon. "FDA Announces Nutritional Guidelines for Frozen Dinners." Cornell Hotel and Restaurant Quarterly, 12 (February, 1972), p. 82.

Voluntary nutritional guidelines for frozen dinners were announced in December by the FDA. Although the guidelines are strictly voluntary, competitive pressure will probably encourage participation. Guidelines are now being prepared for soy products, breakfast cereals, snack foods, and prepared entrees.

13. Anon. "Frozen Food Packers Under the Gun to Meet Nutritional Labeling Deadline." Quick Frozen Foods, 35, (March, 1973), p. 18.

At the time of this article, frozen food packers only had 22 months to use up labels and packaging that did not meet the new nutritional labeling regulations promulgated by the FDA. The principal labeling regulations applicable to frozen food processors are enumerated in the article.

14. Anon. "How Can School Lunch Help 4 Million Hungry Children?" Institutions, 65 (November, 1969), pp. 159-174.

School food service is the natural approach to answer urban hunger problems, but many children are deprived of school lunch because of lack of kitchen facilities. Programs are being introduced to get around this problem. Financing feeding programs is becoming increasingly difficult, due to inflation, and the fact that feeding staffs have trouble keeping lunch prices (paid by the children) down. Most funding money comes from federal sources, and a bill has recently been introduced to try to improve school food service.

15. Anon. "Interstate United Computerizes Hospital Food Service." Fast Food, 70 (November, 1971), pp. 104, 108.

Interstate United has a computer that stores all current recipes, food prices, and nutrient elements that must be considered when preparing a comprehensive hospital menu. Client hospitals have remote typewriter terminals linked to the computer by telephone. The major attributes of each food are stored in the computer memory and incorporated menu cycles are planned.

16. Anon. "Is Eating Harmful to Health?" Institutions, 68 (1971), pp. 51-59.

This is a short report of a series of interviews with food experts about the nutritional habits of the American people.

17. Anon. "Labels That Tell You Something." Journal of the American Home Economic Association, 64 (April, 1972), pp. 28-33.

There are two major options available to protect the nutritional status of consumers: nutrient enrichment and nutrition education. The results of several chain stores' efforts to develop feasible nutrient labeling methods are discussed. Studies performed to determine the level of usage of the labeling demonstrated changes in purchase patterns following the introduction of nutrient labeling, as well as increase knowledge about nutrients. It is believed that food chains and manufacturers are willing to provide consumers with nutrient information, perhaps the next major step may be ingredient or consumer factor labeling. Consumer interest and pressure is the factor which will determine the presence or absence of voluntarily nutrition information on food products.

18. Anon. "The Low-Cholesterol, Low-Fat, Low-Calorie Menu, Please." Fast Food, 72 (May, 1973), pp. 107, 252.

A major hotel chain is now offering low cholesterol, fat, and calorie meals. Its menus are based on substantial reductions or elimination of meat fats, egg yolks, butter, and pan drippings in cooking and baking. The object is not to change people's eating habits, but to give them what they want.

19. Anon. "Low-fat Hot Dogs." Institutions, 65 (December, 1969), p. 78.

Frankfurters with a maximum fat content of 20 percent, sausages with approximately 30 percent fat, and luncheon meats with less than average amounts of fat are available from John Morrell and Company.

20. Anon. "Menu Planners Guide." Fast Food, 70 (January, 1971), p. 26.

General Mills now features a whole line of Bontrae Foods--textured vegetable proteins. They serve as economical, nutritious, convenient protein foods and meat supplements.

21. Anon. "Mini-Meals Mean Maxi Profit." Institutions, 66 (February, 1970), pp. 81-90.

Americans are changing their eating habits to eat more often, but to eat less each time. About 13 percent of family income is spent on food, but in families with a working wife, 30 percent more is spent to "eat out." The higher percentage of eating out means the restaurant industry will have to take more responsibility for serving nutritious meals and snacks.

22. Anon. "More Fortified Foods or Updated Type A Menus." Institutions, 64 (November, 1970), p. 41.

The USDA is revising the Type A menu file to utilize more fully the convenience foods that have come on the market since the last revision.

23. Anon. "New Dimensions in Products." Institutions, 62 (February, 1968), p. 157.

Eggless custard, puddings, and gelatins are all available in a new line of dietetic desserts. All are sugar-free and low in sodium, calories, and fat.

24. Anon. "New Dimensions in . . . Products." Institutions, 63 (September, 1968), p. 152.

A flavor modifier that masks the aftertaste of artificial flavors used in low-calorie foods and beverages as become available.

25. Anon. "The New Foods and the Markets That Need Them." Food Service, 34 (April, 1972), pp. 20-28, 70.

Rapid growth of the food service market, rising costs of food, and increased interest in nutrition have laid the groundwork for product acceptance in food service. New products available are spun and textured soy protein, as well as granular soy protein concentrate products. Markets for the new foods are school food service, hospitals and health care facilities, government institutions, college and university food services, and the fast food market.

26. Anon. "News." Institutions, 72 (April, 1973), p. 72.

The National Advisory Council on Child Nutrition recommends that school feeding programs be made available to all children as soon as possible. The Council also recommends increased participation in child nutrition programs, the use of school facilities for summer feeding programs, and action to insure that new food products are properly monitored.

27. Anon. "News." Institutions, 73 (September, 1973), p. 26.

Advances in technology and a rising demand for protein have resulted in the development of minced fish and peanut flakes. The fish is stripped from the bones by machine. It is as pure and nutritious, yet more economical than whole fish. Peanut flakes are easily flavored, are nutritionally equivalent to soy, and are psychologically acceptable.

28. Anon. "Nutrition Labeling." Nutrition Reviews, 31 (January, 1973), pp. 36-39.

This article provides a description and explanation of the FDA's new comprehensive labeling program. Included are regulations concerning nutrient and vitamin-mineral labeling according to a uniform format, identification of fat and cholesterol content, standards for products sold as dietary supplements of vitamins and minerals, and establishment of rules for the definition and labeling of imitation and artificially flavored foods. A general all-encompassing regulation is stated which will govern labeling.

29. Anon. "Nutrition Labeling II." Nutrition Reviews, 31 (April, 1973), pp. 133-134.

This article presents a brief explanation of the second phase of FDA's food labeling program. The new regulations state that the common name of a food must include a statement of the absence of any characterizing ingredient, and the need for any characterizing ingredient to be added by the consumer. Specific standards for the composition and labeling of frozen "heat and serve" dinners are given. The nutritional quality guidelines proposal delineates the minimum range of nutrient composition for a given food group, thus protecting the consumer against inadequate or excessive fortification.

30. Anon. "Nutrition Labeling III." Nutrition Reviews, 31 (August, 1973), pp. 260-264.

The third phase of FDA's long-range nutrition labeling program includes 14 final orders. Some govern the definition, identity, formulation, and promotion of vitamin and mineral products used as foods, dietary supplements, or drugs. Other final orders deal with false labeling and deceptive promotion of vitamin-mineral supplements (especially vitamins A and D). Provision is made for the establishment of common names for products, which at present may have names confusing to the consumer. A new definition of imitation foods is stated, as well as regulations concerning foods containing spices, flavorings, colorings, and chemical preservatives. Proposed actions stated for public comment have to do with identity standards for mellorine and parevine, restructured foods, filled milk, and chemical preservative labeling.

31. Anon. "Nutrition, Sanitation, Packaging Featured at Cornell Food Seminar." Cornell Hotel and Restaurant Quarterly, 12 (February, 1972), pp. 82-83.

People's eating habits may reflect emotional and social needs rather than nutrition needs. The nutritional content of many well known foods is not well understood, therefore package labels that give the nutritional content might be misleading unless people know the quantities of each nutrient which should be in their daily diet.

32. Anon. "Nutritional Awareness Needed by Food Industry and Customers." Cornell Hotel and Restaurant Quarterly, 12 (February, 1972) p. 82.

More nutrition education for members of the food service industry and for consumers is needed. One in five meals is eaten away from home. Because this figure is rising and due to the wide choices available in restaurant and supermarket foods, people do not always make the best nutritional choices.

33. Anon. "Observations: Let's Look Beyond Nutrition to Identify Proteins." Food Product Development, 5 (August/September, 1971), p. 6.

The FDA must change its requirement of a single standard for both the textured form of vegetable proteins and the products formed from the spun filaments because these materials have different compositions, functional characters, and applications.

34. Anon. "Protein Products: Analogs of Favorite Food Forms." Food Service Magazine, 32 (October, 1970), pp. 38, 40.

We are in an era of consumer flexibility. Food service operators need to be flexible about such labor-saving, high quality food products as meat and poultry analogs.

35. Anon. "Service World Report." Institutions, 69 (September 1, 1971), p. 17.

School lunch programs are facing more rigid rules on eligibility and accounting for free and reduced price lunches.

36. Anon. "Sounds from Capital Hill: More Regulation, More Restrictions." Instituions, 70 (April 1, 1972), p. 33.

Responsibility for nutritional labeling is being placed with the processor and manufacturer, which means the cost will be passed on to the consumer. New nutritional labeling is expected to be optional information but regulated as to wording. Fats are expected to be covered in new FDA regulations, as well as Type A lunches and pre-plated meals.

37. Anon. "Soyburger: It Looks Like Hamburger, But . . ." Fast Food, 72 (May, 1973), pp. 105-106.

USDA researchers report that they believe soy additives will replace about 8 percent of the nation's meat protein by 1980, in everything from pasta to ordinary extruded food. Suggested additives to raise the percentage of protein in macaroni are soy, fish protein, sunflower and cottonseed, and varieties of wheat.

38. Anon. "The Svelte Society: Its Care and Feeding." Institutions, 65 (September, 1969), pp. 127-128.

The food operator's role in dealing with the public's concern with dieting is discussed. Indications are that the food service industry would be fully prepared to cooperate with an established national interest in nutrition. The individual operator feels social and moral pressure to act on nutritional problems, but feels uncertainty as to proper guidelines to follow, due to disagreement among professionals and new scientific findings.

39. Anon. "Things Present and Yet To Come." Institutions, 64 (May, 1969), p. 9.

Lysine enrichment of bread could be a way to provide the proper amounts of protein for undernourished Americans.

40. Anon. "Trends of the Week." Institutions, 72 (May 15, 1973), p. 27.

The USDA is conducting a pilot program to study team teaching of nutrition education by classroom teachers and food service personnel.

41. Anon. "What Can You Learn by Reading the Label?" Consumer Research Magazine, 56 (July, 1973), pp. 25-27.

The FDA is implementing a new program calling for specific information on the identity, quality, and nutritional value of packaged foods. It has also established the U.S. RDA's based on household servings. Under the new program, food processors are responsible for the accuracy of their labels. Some processors have already taken legal steps to seek modification of the labeling regulations. There is question about the usefulness of the nutrient information being required.

42. Howard Appledorf. "Nutrients to Go." Fast Foods, 72 (May, 1973), pp. 102-104.

The author is involved in a series of studies to determine the nutritional value of fast food operation foods. It provides nutritional breakdowns for specialty chicken, hamburgers, and pizza. If a restaurant meal is found deficient in a nutrient, Professor Appledorf recommends that the operation fortify the food or introduce a new food type to make up the deficiency.

43. Aschaffenburg. "The Eighth Decade." Institutions, 66 (January, 1970), pp. 83-115.

The article is a forecast of food service in the 1970's. For the majority of consumers, food service will be standardized and attempts will be made to make it more like "home cooked." New processing techniques, the rise in consumerism (that is, the increased demand for knowledge about ingredients and emphasis on nutrition as a means of preventive medicine), equipment futures, design, education, and labor outlook, and social conscience (the need to meet nutritional standards and needs) are discussed.

44. M. J. Babcock and Margaret Murphy. "Two Nutritional Labeling Systems." JADA, 62 (February, 1973), pp. 155-161.

The effectiveness of "food equivalent" labels and labels listing eight nutrients as percentages of the RDA's per serving were compared in a market test. The food equivalent labels were more effective in guiding typical consumers to buy the more nutritious foods, and would be less costly to consumers. Interviews with 184 customers showed a 7-to-1 preference for the F E label. Eighty-four percent wanted nutritional labeling on all foods, but over half who examined the lists of nutrients said they were confusing or gave too much information.

45. Allen Baker and William Gallimore. "Substitute and Synthetic Foods With Emphasis on Soy Protein." MTS (February, 1972), p. 184.

Dairy, citrus, and other food products have faced competition from newly developed substitutes or synthetic products developed in the past few years. Recent advances in flavoring, coloring, and texturing have added to the acceptability of soy bean products as meat substitutes, as have adverse publicity about animal fat in the diet and the lower price of vegetable protein as compared to animal protein. Projections are made for the type of substitutes to be used in the future.

46. Tom Barrett. "First Lunch Program Under U.S.D.A. Ruling." Institutions, 66 (May, 1970), pp. 33-35.

The USDA has ruled that, after April 1, schools may hire food caterers to prepare and serve lunches, and still get federal reimbursement. Detroit's school system was one of the first in the nation to buy lunches from a food catering service. Each state has the right to establish its own guidelines on federal subsidies.

47. Eulalia Blair. "Low-Cal Dishes--Dieter's Delight." Institutions, 68 (March 15, 1971), pp. 77-81.

This is a diet concious age and there is a market for varied attractive meals that meet caloric demands. Low calorie lunches should be based on a protein food, adding vegetables or a salad, and dessert. Cooking methods should be mainly broiling, baking, or boiling. The focus should be on seasoning, color combinations, and appearance.

48. Dolores Bongolan; Elizabeth Steer; Frederick Joffe, and C. Olin Ball. "Low Temperature Handling of Sterilized Foods." Food Technology, 19 (August, 1965), pp. 1265-1267.

Plum tapioca and split peas with ham were studied to ascertain the effect of processing techniques (HTST v. conventional) and storage time and temperature on thiamin content. The initial superiority of the HTST process over the conventional process and also during storage at various temperatures for from 6 to 12 months was evident. The rate of thiamin loss was primarily a function of storage time and temperature.

49. Jane A. Bowers and Beth Fryer. "Thiamin and Riboflavin in Cooked and Frozen Reheated Turkey." J.A.D.A., 60 (May, 1972), pp. 399-401.

This study compared the effects of gas and microwave ovens on thiamin , riboflavin, moisture, and fat content of turkey muscles. The type of oven had no effect on thiamin retention, but muscle heated by gas had more riboflavin than muscle heated by microwave.

50. M. F. Brink; M. Balsley and E. W. Speckman. "Nutritional Value of Milk Compared with Filled and Imitation Milk." American Journal of Clinical Nutrition, 22 (February, 1969), pp. 168-179.

According to present information, the fat used in many filled milk and imitation milk products is based on hydrogenated coconut oil, high in saturated fatty acids and low in essential fatty acids. The use of this fat for children and people on fat modified diets is questioned. Products identified in this report as imitation milk indicate that they are not replacements for milk in protein, minerals, or vitamins.

51. Joan Bukas. "Breakfast is Boring." Fast Food, 72 (March, 1973), p. 8.

Of an average of 3.9 family members, only 2.9 are present at breakfast. This may be an indication to food service operators and manufacturers that stronger breakfast business could be developed in restaurants and schools. Appropriations by the federal government for school breakfast programs have risen, but the use of the vitamin fortified cakes, approved by the government is criticized for encouraging poor nutritional habits.

52. I. H. Burger and C. L. Walters. "The Effect of Processing on the Nutritive Value of (Flesh) Food." Proceedings of the Nutrition Society, 32 (1972), pp. 1-8.

This paper reviews the effects of curing, heat processing, freeze-drying, freezing and storage, and domestic handling on the nutritive value of flesh foods. Recommendations for future investigation are included.

53. Susan Butterfield and Doris Howes Calloway. "Folacin in Wheat and Selected Foods." J.A.D.A., 60 (April, 1972), pp. 310-314.

Wheat fractions and bread made from these fractions were analyzed for free and total folacin. Of the wheat fractions assayed, germ and bran were highest in folacin, and whole wheat flour had twice as much as baker's patent flour. Folacin content of single strength orange juice was retained in the frozen concentrate.

54. R. F. Cain. "Water Soluble Vitamins--Changes During Processing and Storage of Fruit and Vegetables." Food Technology, 21 (July, 1967), pp. 60-69.

With three exceptions, heat adversely affects vitamin retention, and the response to other environmental factors is mixed. The effects of washing, subdividing, blanching, cooling, irradiation, freezing, and dehydration on nutrient retention are discussed.

55. Doris Howes Calloway. "Dehydrated Foods." Nutrition Reviews, 20 (September, 1962), pp. 257-260.

The effects of dehydration on all categories of food are discussed. Under the best conditions, no dehydrated food could be expected to be superior in nutritive value to the corresponding frozen product, due to the many steps in processing where nutrients may be lost.

56. K. C. Chen; B. S. Luh; and M. E. Seehafer. "Chemical Changes in Strained Peas Canned by the Aseptic and Retort Processes." Food Technology 24 (July, 1970), pp. 821-826.

Strained green peas of 9.6% total solids were canned both by aseptic and retort processes. The aseptically canned product was lower in titratable acid and higher in pH than was the retorted product. Aseptic canning allowed a higher level of free amino acids in the canned product.

57. R. S. Clausi. "Improving the Nutritional Quality of Food." Food Technology, 27 (June, 1973), pp. 36-40.

The food industry can nutritionally modify food to make the long-term consequences of poor eating habits less severe. Nutritional modification can be accomplished through fortification of convenience foods the use of food analogs, and nutritional adjustments. Nutrition education programs are necessary to help consumers use nutrition information. Foreseeable marketing, regulatory, and technical problems are discussed.

58. Merrill Cohen. "Letters to the Editor." Fast Food, 72 (March, 1973), p. 36.

The average consumer may not use the information required on food products, due to a lack of ability or a lack of desire.

59. Sylvia Cover and W. H. Smith, Jr. "Effect of Moist and Dry Heat Cooking on Vitamin Retention in Meat from Beef Animals of Different Levels of Fleshing." Food Research, 21 (1956), pp. 209-216.

Thiamin and niacin retentions were higher in the meat of broiled than in the meat of braised steaks. The meat of oven roasts contained less thiamin but more niacin than the meat of pot roasts. Evaporation from the surface of the meat during cooking by dry heat, or washing of the surface by condensing steam by moist heat may be significant factors affecting retention of thiamin and niacin. Internal temperatures may also affect thiamin retention.

60. Kathleen Cutlar. "The Nation's School Lunch Program." Cornell Hotel and Restaurant Quarterly, 9 (August, 1968), pp. 10-19.

The 1968 scope of the school lunch program is given, complete with calculations on the number of meals served and to whom. The international and national history and provisions of the school lunch program are stated, as well as reasons for the implementation of the Type A program.

61. E. J. Day; H. E. Alexander; H. E. Sauberlich and W. D. Salmon. "Effects of Gamma Radiation on Certain Water-Soluble Vitamins in Raw Ground Beef." Journal of Nutrition, 62 (May, 1957), pp. 27-37.

The destructive effect of irradiation on a particular nutrient depends largely on the medium in which the nutrient is suspended. Gamma radiation of raw ground beef resulted in destruction of riboflavin and pyridoxine. Little of inositol, niacin, or tryptophan was destroyed.

62. A. P. DeGroot. "The Influence of Dehydration of Foods on the Digestibility and the Biological Value of the Protein." Food Technology. 17 (March, 1963), pp. 339-343.

The nutritive quality of proteins in twelve different cooked food items was compared with that of the corresponding cooked products after dehydration by practical methods. Dehydration did not result in serious damage to the protein. Generally, dehydration in hot air showed more indications of slight protein damage than did spray drying or freeze drying.

63. Department of Health, Education and Welfare. "Consumer Register." Consumer News, 3, supplement (March 1, 1974).

The FDA has delayed the effective date for increasing iron levels in bread and flour products until January 1, 1975, in order to consider the outcome of a heating being held to voice objections to iron enrichment. Reasons for opposition to enrichment are listed. There is fear that enrichment may become mandatory.

64. Department of Health Education and Welfare "Consumer Register." Consumer News, 2, supplement (October 15, 1972).

An announcement of the deadline for comments on the FDA proposal to amend the standard of identity for certain milk products is given. The proposal would allow addition of emulsifiers and stabilizers to improve milk consistency.

65. Mary S. Eheart. "Effect of Microwave vs. Water Blanching on Nutrients in Broccoli." J.A.D.A. 50 (March, 1967), pp. 207-211.

Broccoli was blanched by microwave and water methods, frozen and stored for as long as a year. The microwave blanced broccoli was higher in total acids, ascorbic acid, and percentage retention of chlorophyll. After frozen storage and cooking, the microwave blanched broccoli was lower in pH, higher in total acids and ascorbic acid, but lower in chlorophyll than the broccoli blanched in 100-degree water. It is indicated that the largest loss of ascorbic acid in the frozen broccoli was caused by blanching while the largest loss of chlorophyll was due to cooking.

66. Gladys J. Everson; JoAnne Chang; Sherman Leonard; B. S. Luh and Marion Simone. "Aseptic Canning of Foods II Thiamin Retention as Influenced by Processing Method, Storage Time and Temperature, and Type of Container." Food Technology, 18 (January, 1964) pp. 84-86.

A tomato juice concentrate, strained lima beans, and strained beef were processed by aseptic and conventional canning procedures to compare the amounts of thiamin lost. Thiamin retention significantly improved when low-acid foods are processed aseptically. Some thiamin was lost from all three groups during storage, due to some extent to storage temperatures. Processing method did not seem to affect sotrage losses.

67. Gladys J. Everson; JoAnne Chang; Leonard Sherman; B. S. Luh and Marion Simone. "Aseptic Canning of Foods III Pyridoxine Retention as Influenced by Processing Method, Storage Time and Temperature and Type of Container." Food Technology, 18 (January 1964), pp. 87-88.

Strained lima beans, strained beef, and tomato juice concentrate were processed by canning aseptically and conventionally. The low-acid products exhibited little difference in pyridoxine values after the procedures were completed. Loss of pyridoxine after nine months of storage was approximately one-fifth of processed values and was independent of method and container. Tomato juice retained full pyridoxine values throughout processing and storage.

68. Karl Folkers. "Communicating With the Consumer: Natural and Synthetic Nutrients; Special Report: Part III." Food Product Development, 6 (August-September, 1972), pp. 61-62.

The author gives a brief sketch of the history of the discovery of natural nutrients and how they came to be synthesized chemically. The production of synthetic nutrients in mass quantities became a boon to man by making it possible to nutritionally improve the food he eats and so benefit his health and prolong his life. The author suggests that the population be informed about these synthetic nutrients by presenting them in terms of their relationship to corresponding natural substances.

69. FDA. "Food Labeling." Federal Register, 38 (January 19, 1973), pp. 2123-2164.

This is the official public printing of the third phase of FDA's nutritional labeling actions and proposals. The document first discusses consumer comments to proposed nutrition labeling then deals with the consideration of new proposals concerning cholesterol, fat, and fatty acid composition labeling. New proposals were set forth concerning the definition of imitation foods, and foods containing added flavorings, spices, coloring, and chemical preservatives. The report of public hearings on special dietary foods is given and labeling statements are recommended, as well as definitions and standards of identity. Requests for comments are made for prospective requirements for manufacturers, packers, and distributors of food.

70. FDA. "Food and Food Products." Federal Register, 38 (August 2, 1973), pp. 20701-20750.

Regulations are discussed concerning application of the term "imitation" to foods and an announcement is made concerning the date the regulations take effect. A final order is stated concerning label statements. Effective dates are anncunced for labeling to comply with FDA findings on foods purporting to be or represented for special dietary uses, as well as for foods containing spices, flavoring, coloring, and chemical preservatives. Statements of policy and effectiveness dates are given for vitamins A and D, folic acid, potassium, iodid, and kelp. Orders are issued for foods with no standard identity and dietary supplements of vitamins and minerals, foods packaged for use in the preparation of "main dishes," common names for nonstandardized foods. Comments are requested.

71. FDA. "Cereal Flours and Bakery Products; Improvement of Nutrient Levels." Federal Register, 38 (October 15, 1973), pp. 28558-28564.

Objections to enrichment of baked goods are stated and discussed. The proposed amendments are modified and accepted. Identity standards are given for enriched flour and enriched bread, rolls, and buns; statements of optional ingredients on labels are given.

72. FDA. "Food Labeling." Federal Register, 38 (January 19, 1973), pp. 2124-2164.

New and revised FDA regulations on information panels, label designation of ingredients for standardized foods and nutrition, cholesterol, fat, and fatty acid labeling are given. Also, proposals for standards on imitation foods and foods with added flavor, exemptions from requirements, the nutritional labeling of frozen desserts, vitamin and mineral supplements, and special dietary uses are discussed.

73. Brian Fox and Allen Cameron. "Cooking and Diet." Food Science--A Chemical Approach, 2nd ed. (Lowden: University of London Press Ltd, 1970), pp. 273-304.

The book's focus is upon the functions and use of food as related to the human body. Cooking methods and their effects on nutritive value of food are discussed.

74. Food and Nutrition Board, National Academy of Sciences. General Policies in Regard to Improvement of Nutritive Quality of Foods from (National Research Council: Washington, D.C., 1973), pp. 1-6.

Restoration of nutrients lost in food processing has long been recognized as a means of improving nutritional values of food. The Food and Nutrition Board endorses enrichment or fortification under certain specified conditions. The Board encourages the development of new economically advantageous foods to provide superior nutritional quality and greater variety and acceptability.

75. Berta Friend. "Enrichment and Fortification of Foods, 1966-70." National Food Situation, 142 (November, 1972), pp. 29-33.

Based on a recent survey covering 1966-70, enrichment and fortification supplemented nutrients in the 1970 food supply occurred in the following percentages: thiamin 40 percent; iron, 25 percent; niacin, 20 percent; riboflavin, 15 percent; vitamin A value, 10 percent; ascorbic acid, 10 percent; vitamin B_6, 4 percent; and vitamin B_{12}, 2 percent.

76. FDA. "Food Labeling." Federal Register, 38 (March 14, 1973), pp. 6949-6975.

This is the official printing of follow up action to the January 19, 1973, publication of nutrition labeling regulations by the FDA. A summary of comments on the food label information panel suggested in the previous document is presented, as well as comments concerning nutrition labeling (including the question of mandatory adherence). Comments were received dealing with labeling of foods with information on cholesterol, fats and fatty acids; common names for nonstandardized foods and some standardized foods; principles and guidelines for the labeling of frozen dinners; and nutritional quality guidelines for frozen "heat and serve" dinners. Proposals are presented for beverages with no juice content, common names, and content for frozen "heat and serve" dinners, and common names for foods packaged for use in preparation of dishes or dinners.

76a. J. A. Fries and D. M. Graham. "Reconstituting Preplated Frozen Meals with Integral Heat." Food Technology 26 (November, 1972), pp. 76-82.

Integral heat is produced when electrical energy is transformed to heat generated on the inside surface of a special casserole dish. Large lots of frozen beef tenderloin, blanched peas and potatoes were heated with integral heat, and ascorbic acid levels were determined. It was found that vitamin C loss for peas and potatoes was significantly higher using convection heat than integral heat.

77. C. F. Garjes and R. J. Smith. "Nutritive Analysis of Frozen Fully Cooked Institutional Foods." Food Technology, 24 (September, 1970), pp. 49-50, 52, 64.

Methods for the analysis of fully cooked, frozen prepared foods were developed in order to facilitate selection of foods suitable for special diets. The author predicts changes in laws concerning food handling and processing.

78. Janice Garr. "Menu Planner's Guide." Fast Food, 732 (June, 1973), p. 25.

In July of 1973 General Foods will put the first nutritionally fortified gelatins (fortified with iron and vitamins A and C) on the food service market.

79. S. A. Goldblith. "Thermal Processing of Food," A Review in The World Review of Nutrition and Dietetics, 13 Edited by Geoffrey A. Bovine, S. Karger, and A. G. Basel (Switzerland, 1971), pp. 165-193.

The effects of heat processing and storage on the nutritive value of raw foods is discussed. It was found that by the use of HTST blanching nutritive value could be retained with no sacrifice in quality. The need for temperature controlled storage is clearly indicated to preserve thiamine. Speculation about future trends is given.

80. Samuel Goldblith; Marcus Karel and Graham Lusk. "Freeze 'Dehydration of Foods." Food Technology, 17 (February, 1963), pp. 21-26.

Dehydration and subsequent storage produce ill-defined changes thought to be related to food protein. The changes include toughening of the tissue of seafood and meat products and lowering of their water holding capacity. Changes are usually attributed to denaturization of protein, probably through localized high concentrations of salt.

81. S. Goldblith; S. Tannenbaum and D. Wang. "Thermal and 2450 MHz Microwave Energy Effect on the Destruction of Thiamin ." Food Technology, 22 (October, 1968), pp. 1266-1268.

Destruction of thiamin in a pH 6.8 phosphate buffer solution was determined using conventional microwave cooking methods. It was shown that the degree of destruction of thiamin by microwave energy was due solely to temperature and that microwaves per se have no effect on the destruction of thiamin .

82. Joan Gordon and Isabel Noble. "Comparison of Electronic vs. Conventional Cooking of Vegetables." J.A.D.A., 35 (March, 1959), pp. 241-244.

Flavor, color, and ascorbic acid retention in vegetables of the cabbage family cooked by boiling water, pressure saucepan, and electronic range methods have been studied. Vegetables cooked in boiling water were milder in flavor and greener in color than those cooked by either of the other two methods. The mean percentage retentions of ascorbic acid in vegetables cooked in the electronic range were greater than those in samples cooked in the pressure saucepan; these in turn were greater than in samples cooked in boiling water.

83. George G. Graham. "Dietary Protein Quality in Infants and Children - VII Corn Soy-Wheat Macaroni." J.A.D.A., 51 (September, 1972), pp. 280-286.

A corn-soy-wheat macaroni with 21 percent protein was evaluated in feeding trials with malnourished infants. Digestability of the protein was close to that of modified cow's milk and net protein utilization was approximately 75 percent of that of casein. The biological value was demonstrated in initiating recovery of severely protein-depleted infants. In tests in Peru, Brazil, and the Southern U.S., the product has been shown to be highly acceptable.

84. David Hanks. "$1 Billion for School Lunch." Institutions, 69 (September 15, 1971), p. 27.

One billion dollars have been approved for school lunch and related programs. Most of the money goes to the 50 states, a smaller proportion for nutrition education, and another portion for federal administration of the school lunch program. Schools will receive money partially to pay for all meals and additional money to cover the cost of those students who cannot afford to pay anything. Further funds will go for food service equipment.

85. David Hanks. "Schools Start Nutrition Education." Institutions, 69 (September 15, 1971), p. 27.

The Durham, North Carolina schools are implementing a nutrition education program funded by the Office Education, HEW. It is the only one of eight education pilot programs where monies went for food service. The program involves both children and their parents in classroom and kitchen training.

86. David Hanks. "Day Care--A $10 Billion Baby." Institutions, 70 (February 15, 1972), pp. 51-60.

Day care facilities are increasing in number and importance. Food service is playing an increasingly important role in these schools. Nutrition information is inculcated by allowing the children to participate in the preparation of food and by planning total experiences dealing with food.

87. Judson Harper and Richard Jansen. "Nutrient Standard Menus." Food Technology, 27 (June, 1973), pp. 48-49.

Menu planning based on meeting specific nutrient requirements has important advantages over planning on the basis of food groups. For example, often food items do not fit into one specific food group, but are composed of several food types. Requirements for Nutrient Standard Menus techniques developed (including the abacus method, computer, and group methods), and applications of the NMS are discussed.

88. Harvey Hearl. "Foods of the Future." Cornell Hotel and Restaurant Quarterly, 11 (August, 1970), pp. 18-20.

In the year 1985, protein requirements may be met by high protein grains, imitation milk, the substitution of coconut oil for butter fat, soy protein for milk protein, algae protein grown on sewage, fish flour, and petroleum protein. Foods from new rice strains, and improved fruits and vegetables will meet the requirements for carbohydrates, fats, and minerals.

89. Edward J. Hekman. "U.S.D.A. Gives Specifications for Textured Vegetable Protein Product." Modern Schools Magazine (September, 1971), pp. 13-14.

This article specifies the use of TVP in school food lunches as an alternate to meet part of the minimum requirements of two ounces of cooked meat. It must be prepared and served in combination with ground or diced meat and shall not exceed 30 parts in 100. The ingredients are specified as well as chemical composition and biological value.

90. E. W. Hellendoorn; A. P. deGroot; L. P. van der Myll Dekker; P. Slump and J. J. L. Williams. "Nutritive Value of Canned Meals." J.A.D.A., 58 (May, 1971), pp. 434-441.

Meals consisting of meat, vegetables, pulses, and potatoes were studied for the effect of heat sterilization and prolonged storage on nutritive value of the canned product. Considerable losses were noticed in vitamin A, thiamin, niacin, and pantothenic acid both during sterilization and storage. The protein quality of most products decreased slightly during sterilization and further during storage. The nutrient content of the canned foods showed deficiencies of Ca, vitamin A, thiamin, and riboflavin.

91. A. Z. Hodson. "Nutritive Value of Instant Nonfat Dry Milk." Food Technology, 10 (May, 1956), pp. 221-224.

On a reconstituted basis, the thiamin , riboflavin, niacin, pantothenic acid, and vitamin B_6 contents of two brands of instant nonfat dry milk are essentially equal to those of fresh milk samples. The ascorbic acid content of nonfat dry milk is low and may be decreased by conversion to instant powder, but as milk is not a strong source of vitamin C, this is of minimal importance. The conversion of nonfat dry milk to instant by a commercial process does not measurably change the thiamine, riboflavin, nicotinic acid, pantothenic acid, or B_6 content.

92. D. F. Hollingsworth. "The Nutritional Value of A.F.D. Foods." in S. Cotson and D. B. Smith Freeze-Drying of Foodstuffs (Manchester, England: Columbine Press Ltd., 1963), pp. 149-156.

Protein, iron, riboflavin, and nicotinic acid values are little affected by dehydration and storage, whereas vitamin A may be partially destroyed by oxidation in unsatisfactory storage. Vitamin C is affected by dehydration and storage, and thiamin enjoys fairly good retention except when sulphite is used. Storage conditions of dehydrated food are very important--air, moisture, and heat are all destructive. Cooked dehydrated foods should be nutritively similar to fresh if excessive losses have not been incurred during storage.

93. Dorothy Hollingsworth. "Effects of Some New Production and Processing Methods on Nutritive Values." J.A.D.A., 57 (September, 1970), pp. 246-249.

Changes in agricultural methods and food processing may affect the nutritive values of the foods we eat. To document such changes--necessary in evaluating food consumption of a nation--the author reports on a program of studies of different foods that is being carried out in the United Kingdom. The effect of processing methods of foods for young children is also considered by the author.

94. K. Hoppner; B. Lampi and D. E. Perrin. "Folacin Activity of Frozen Convenience Foods." J.A.D.A., 63 (November, 1973), pp. 536-559.

Thirty prepared frozen convenience dinners were analyzed for free and total folacin activity. The bulk of folacin activity was contributed by vegetables, with potatoes and meat following in that order. Additional losses due to reheating of the dinners were not significant for TFA, but FFA values decreased with losses averaging 22 percent. Twelve model dinners were chosen according to recent FDA regulations and minimum folacin level calculations were 12 mcg./100 kcal and/or 41 mcg/dinner.

95. Richard Jansen and Judson Harper. "Nutritional Aspects of Nutrient Standard Menus." Food Technology, 28 (January, 1974), pp. 62-67.

NSM and food-group-based menus are both subject to the same difficulties in obtaining actual food composition. The article states points that must be considered when planning a meal by the NSM method.

96. R. L. Jenkins. "Freeze-Dried Foods." Cornell Hotel and Restaurant Quarterly, 9 (August, 1968), pp. 20-28.

The article defines freeze drying and describes the process. It lists advantages and disadvantages of freeze dried foods.

97. Leslie Kahn and G. E. Livingston. "Effect of Heating Methods on Thiamine Retention in Fresh or Frozen Prepared Foods." Journal of Food Science, 35 (1970) pp. 349-351.

Thiamin retentions were determined in beef stew, chicken a la king, shrimp newburg, and peas in cream sauce in the freshly prepared state, frozen and reheated with microwaves, infrared heating, or boiling water immersion. The average thiamin retentions observed were highest in frozen-microwave heated, next in frozen-infrared heated products. The lowest retention was in the fresh hot products after three hours of holding.

98. Endel Karmas; John Thompson and David Peryam. "Thiamin Retention in Freeze-Dehydrated Irradiated Pork." Food Technology, 16 (March, 1962), pp. 107-108.

Thiamin retention was measured in freeze-dehydrated pork irradiated at different levels. Irradiation between the levels of 0-4.5 megerads gave no significant destruction of thiamin , but freeze dehydrating destroyed about one-third of the initial thiamin content.

99. Arnie Katz. "The Big Debate: Should FF Be Fortified?" Quick Frozen Foods, 35 (August, 1972), pp. 54-55.

Many frozen food packers are considering boltering the nutritional content of their frozen foods with vitamins as an aid to producing foods that will contribute to a more healthful diet for Americans. Fortification is one tool manufacturers can use to meet FDA regulations. The danger of a "vitamin race" of overfortification between food manufacturers could be diminished if additives were regulated on the basis of protein rather than calorie content.

100. Stephen Kech. "School Food service." Fast Food, 71 (November, 1972), pp. 48-52, 54, 56, 60.

School lunch directors are trying to encourage children to consume nutritionally balanced meals by testing various new foods--including ethnic foods. A list of foods that meet or exceed USDA nutrition standards and, at the same time, present a palatable meal is included in the article. Parents object to the use of prepared meals for their children, favoring instead food prepared as it is at home. Rising labor costs make "like home" preparation increasingly difficult, but satellite kitchens may be one answer to the problem. Parents generally object to the use of fortified cakes, pies, and donuts for school breakfasts.

101. Lois Kilgore and Maybell Bailey. "Degradation of Linoleic Acid During Potato Frying." J.A.D.A., 56 (February, 1970), pp. 130-132.

Linoleic acid degradation occurs in fats used for frying. The percentage of linoleic acid extracted from fat following the frying of ten pounds of potatoes was highest for cottonseed oil and lowest for shortening, with safflower oil and corn oil approximately even in between.

102. Lois Kilgore and Frances Windham. "Degradation of Linoleic Acid in Deep-Fried Potatoes." J.A.D.A., 63 (November, 1973), pp. 525-527.

Frozen, deep-fried potatoes were fried in a blend of cottonseed and soybean oil and then frozen. After six months in the frozen state, the potatoes were heated in deep fat, in conventional ovens, and in microwave ovens. The percentage of total fatty acids in the first pound of potatoes reheated was greater than in the twelfth pound.

103. Amihud Kramer. "Storage Retention of Nutrients." Food Technology, 28 (January, 1974), pp. 50-51, 53-54, 55, 56, 58, 60.

Some nutrients (total protein content, caloric value, niacin, vitamin A, and minerals) in freshly processed foods are retained for very long periods of storage. At high temperatures, retention of these nutrients can be significantly decreased. In or[illegible] to comply with labeling regulations, the processor can (1) declare nutrient levels substantially less than levels assayed immediately after processing. in order to compensate for storage losses, or (2) store the processed foods at temperatures low enough to ensure nutrient retention.

104. Herman Kraybill. "Nutritive Effects on Foods Sterilized by Ionizing Radiations." Nutrition Reviews, 13 (July, 1955) pp. 193-195.

Thermal treatment and freezing of foods has drawbacks, like the cost of operations and the storage space required. Radiation sterilized food does not have the same drawbacks. During radiation sterilization a dosage exceeding five million rep must be used to inactivate enzymes and prevent the breakdown of food. The reactions of the different nutrients to the irradiation process is discussed.

105. Williard Krehl and R. W. Winters. "Effect of Cooking Methods on Retention of Vitamins and Minerals in Vegetables." J.A.D.A., 26 (December, 1950) pp. 966-972.

Twelve different vegetables representative of those used by the average homemaker were assayed on the fresh basis for a variety of nutrients, then prepared four different ways. The data obtained clearly showed that the greatest retention in minerals and vitamins was obtained when vegetables were cooked without added water; the least retention was found when water to cover was used.

106. Anne Kylen; Virginia Charles; Barbara McGrath; Janet Schleter; Leeta West and Frances VanDuyne. "Microwave Cooking of Vegetables." J.A.D.A., 39 (October, 1961), pp. 321-326.

The amounts of ascorbic acid retained in seven fresh and three frozen vegetables were not significantly different when the vegetables were cooked by a conventional and a microwave method.

107. T. P. Labuza. "Effects of Dehydration and Storage." Food Technology, 27 (January, 1973), pp. 20-26.

Due to the fact that nutritional labeling may soon become mandatory, it is important for processors to predict the extent of deterioration of nutritive factors during processing. To predict nutrient losses, a researcher must know the cooking time, the temperature, and the moisture content. The effects of dehydration and storage on several different foods was studied in connection with protein degradation and the loss of biological value, fat, and water soluble vitamins.

108. Paul A. LaChance; Arvind Ranadive and Jonathan Matas. "Effects of Reheating Convenience Foods." Food Technology, 27 (January, 1973), pp. 36-38.

Three experiments were performed to compare assay values for reduced ascorbic acid and thiamin from canned and frozen convenience foods, before and after heating, with the values reported in Handbook 8. In all experiments, the values showed discrepancies. Reasons are given to explain the discrepancies. The results indicate serious consideration about supplementing convenience foods with additional amounts of micro-nutrients.

109. Paul A. Lachance. "Basic Human Nutrition and the RDA." Food Product Development, 6 (December-January, 1973), pp. 64-68.

Nutrition is the relationship of food to the functioning of the body. Food choices are the result of the sum of a person's culture and traditions, desires and emotions, character and experiences. The RDA's are intended to serve as goals for planning food supplies and as guides for the interpretation of food consumption records of groups of people.

110. K. Lang. "Influence of Cooking on Foodstuffs." from World Review of Nutrition and Dietetics, 12 (Karger, Basel-Munchen, N.Y.: 1970), pp. 266-317.

This article represents an extensive and complete review of the effects of different methods of cooking on proteins, fats, carbohydrates, and vitamins.

111. R. J. Lenahan; J. A. Thomas, D. A. Taylor; D. L. Call and D. I. Padberg. "Consumer Reaction to Nutrition Information on Food Product Labels." Search (Agriculture), 2 (1972), pp. 1-26.

Two separate consumer surveys, a national probability sample dealing with label formats and non-use benefits, and local surveys dealing with four independent market's labeling programs, are reported. Both surveys showed that the label stating nutrient content with the percentage of RDA was the preferred format. In the national survey, it appears that the groups needing nutritional improvement most would make the least use of the labels, the value of the nutritional labels was thought to be greater for potential use, and there was strong agreement on non-use benefits. In the local supermarket survey, perception and understanding and use of the labels increased with the length of time the program was in effect, and the non-use benefits of the system were recognized. Program benefits were perceived to be nutrition education, more nutritious food products, and more value for each food dollar.

112. Lois Lindauer. "Diet is Not Just a Four-Letter Word." Fast Food, 71 (January, 1972), pp. 64-69.

According to an HEW report two-thirds of the people in the U.S. are on weight reduction diets or are watching their weight for other reasons. In order to capitalize on the diet market, the food service operator must use a total approach: basic nutritional requirements, food preparation, menu presentation, pricing, purchasing and inventory. The Diet Workshop program is discussed.

113. Ellen Liu and S. J. Ritchey. "Nutritional Value of Turkey Protein." J.A.D.A., 57 (July, 1970), pp. 38-41.

Turkey meat heated in an electric oven for up to two hours did not experience significantly altered nutritional quality, whereas heating the turkey in an autoclave for 24 hours caused a significant loss in all parameters tested (weight gain, PER, biological value, and percentage digestibility in rats). Turkey protein was found to be an excellent supplement to poorer quality proteins.

114. G. E. Livingston; Catherina Ang and Charlotte Chang. "Effects of Food Service Handling." Food Technology, 27 (January, 1973), pp. 28-34.

Food service operations--raw material handling, food preparation, and service of prepared food--are examined to determine if they optimize the retention of natural nutrients in food. Such modern food service methods as ingredient substitution, formulated foods, frozen foods (entrees), and centralized systems are examined to determine their effect on nutritional quality.

115. Alfredo Lopez; W. A. Krehl and Eleanor Good. "Influence of Time and Temperature on Ascorbic Acid Stability." J.A.D.A., 50 (April, 1967), pp. 308-310.

Ascorbic acid in citrus juices and in certain chemical solutions containing ascorbic acid is stable, even for long periods at room temperature, provided storage and dilution conditions are satisfactory.

116. B. S. Luh and F. B. Sioud. "Aseptic Canning of Foods IV Stability of Pear Puree with Essence Recovery." Food Technology, 20 (December, 1966), pp. 1590-1593.

Pureed pears were canned aseptically and stored at temperatures ranging from 32 degrees to 98 degrees F. The puree stored at the higher temperatures exhibited an increase in titratable acidity, decreased pH, darkening color after 180 days, and formation of hydroxymethyl furfural, indicating poor quality. Puree stored at lower temperatures did not show evidence of color change and did not develop hydroxymethyl furfural.

117. D. B. Lund. "Effects of Heat Processing on Nutrient Retention in Foods." Food Technology, 27 (January, 1973), pp. 16-18.

This article offers a brief review of the effects of heat processing on proteins, carbohydrates, vitamins, and trace minerals.

118. L. W. Mapson. "Effects of Processing on the Vitamin Content of Foods." British Medical Bulletin, 12 (1956), pp. 73-77.

Loss of nutrients in vegetables, meat and fish, eggs, and milk products is discussed in relation to the various processing methods and preparation methods used to present the finished product to the consumer.

119. Helen Mayfield and Marjorie Hedrick. "Thiamin and Riboflavin Retention in Beef During Roasting, Canning, and Corning." J.A.D.A., 25 (December, 1949), pp. 1024-1027.

The effect of roasting, canning, and corning on the thiamin and riboflavin content of beef from cattle fed grass and grain was studied. Thiamin retention during canning was slightly higher in metal cans than glass jars, but in both cases losses were great. Riboflavin seemed to increase significantly during canning. Thiamin retention was about one-quarter to one-half after corning, but riboflavin retention was very high. Losses in both thiamin and riboflavin resulted from further cooking after corning.

120. V. Chalan Melta and Connor Johnson. "The Effect of Radiation Sterilization on the Nutritive Value of Foods." Journal of Nutrition, 59 (August, 1956) pp. 479-489.

The effect of irradiation sterilization and of heat sterilization on the nutritive value of milk proteins and beef proteins was studied. Upon irradiation, the milk developed a reddish tinge and the proteins coagulated; the beef darkened. Irradiation did not produce off flavors or odors. Irradiation sterilization did not affect the apparent or true digestability of the beef or milk. The biological value of the beef was not affected, but the milk's biological value was reduced as compared to heat sterilized milk.

121. Neil Mermelstein. "Nutrient Labeling and the Independent Laboratory." Food Technology, 27 (June, 1973), pp. 42-46.

After deciding whether he will label his product a food manufacturer must decide how extensively to analyze the product to ensure that the values stated on the label will accurately represent the nutritional content of the product as it reaches the consumer. He must know how to choose a laboratory and consider the cost involved. A range of fees is included giving the charges for nutrient analysis by seven independent laboratories.

122. Dorothy Miskimin; James Bowers and Paul LaChance. "Nutrification of Frozen Preplated School Lunches is Needed." Food Technology, 28 (February, 1974) pp. 52-56.

Analysis of the nutritive value of 156 frozen preplated Type A meals revealed one-third of the RDA was always provided for protein, niacin equivalents, and riboflavin, but in increasing order of frequency vitamin C, phosphorus, vitamin A, calcium, thiamine, calories, and iron were found to be lacking. Suggested as a solution to this problem is the use of nutrient standard meals. The authors recommend nutrification of preplated meals since it is evident that there is not optimal intake of RDA nutrients, and since menu planning alternates may not be acceptable.

123. W. B. Murphy. "Some Things You Might Not Know About the Foods Served to Children." Nutrition Today, 7 (September-October, 1972) pp. 34-35.

The author advances the opinion that textured protein has not been sufficiently tested in long-term feeding experiments; therefore its use should not be unquestionably accepted. He also states that food should be bought on value because nutrition and child acceptance are of paramount importance.

124. Isabel Noble and Lucille Gomez. "Vitamins in Electronic Cooking." J.A.D.A., 41 (September, 1962), pp. 217-220.

Comparisons of thiamin , riboflavin, fat, moisture, and weight changes in lamb rack and loin roasts were made using electronic and conventional ranges. Results of the use of the two cooking methods were not significantly different for any of the tested factors.

125. Isabel Noble. "Thiamin and Riboflavin Retention in Broiled Meat." J.A.D.A., 45 (November, 1964), pp. 447-450.

Pan and oven broiled cuts of beef, pork, and lamb were not significantly different in the percentages of thiamin and riboflavin they retained. Comparisons based on the three types of meat showed that thiamin retentions in beef and pork were not significantly different but were higher than in lamb. Riboflavin retention in beef was significantly higher than in pork and lamb, which were similar.

126. Isabel Noble. "Thiamin and Riboflavin Retention in Braised Meat." J.A.D.A., 47 (September, 1965), pp. 205-208.

The effect of braising on various cuts of beef, veal, and pork are reported, as to thiamin and riboflavin retention.

127. Isabel Noble. "Thiamin and Riboflavin Retention in Cooked Variety Meats." J.A.D.A., 56 (March, 1970) pp. 225-228.

Braised meats (sweetbreads, beef kidney, lamb and pork heart) retained a larger proportion of thiamin than did the simmered meats, but not of riboflavin. Sweetbreads retained the most thiamin ; beef, veal, and pork heart retained the lowest amounts of thiamin , but the highest amounts of riboflavin.

128. Fred O'Hara; Jerry Santini; S. Kent Dohrman; and Jean Schroeder. "Central Commissaries: Three Examples of an Evolving Food Service Concept." J.A.D.A., 63 (October, 1973), pp. 422-426.

A central commissary system consists of a central food storage facility and manufacturing plant which provides food for service at satellite locations. Storage and transportation during the "thermic break" can result in large expenditures. The central commissary systems are described.

129. M. L. Kakieten; B. Newman; K. B. Falk and I. Miller. "Comparison of Some Constituents in Fresh-Frozen and Freshly Squeezed Orange Juice." J.A.D.A., 27 (October, 1951), pp. 864-868.

The purpose of this study was to compare the amounts of constitutents of fresh-frozen reconstituted orange juice with those present in freshly-squeezed orange juice, home prepared. Values for ascorbic acid in the frozen product averaged better than those in fresh juice. Under usual home refrigeration temperatures, there was no significant loss of ascorbic acid in either the fresh-frozen or freshly squeezed juice.

130. Elwood Reber and Mark Bert. "Protein Quality of Irradiated Shrimp." J.A.D.A., 53 (July, 1968), pp. 41-42.

Commercially processed shrimp were irradiated at two different levels and were either cooked or left untreated. All shrimp were freeze dried and protein quality was evaluated. Protein quality of irradiated, cooked, and untreated shrimp were compared and found to be statistically equal.

131. B. A. Rolls and J. W. G. Porter. "Some Effects of Processing and Storage on the Nutritive Value of Milk and Milk Products." Proceedings of the Nutrition Society, 32 (1973), pp. 9-15.

Liquid milk, processed by holder process or HTST does not take on a cooked flavor, and will keep for several days if cool. The UHT method (used for long term sterilization of liquid milk) allows milk to be kept several months without refrigeration. Fat, fat soluble vitamins, carbohydrates, and minerals of milk are virtually unaffected by heat treatment, but in-bottle sterilization and UHT methods may cause losses in the true digestability of protein and BV. Conventional pasteurization has little effect on water soluble vitamins, except for Vitamin C whereas in-bottle sterilization causes considerable losses of vitamins. The nutritive values of concentrated milks, cheese, and dried milks are discussed.

132. Daniel Rosenfield. "Utilizable Protein: Quality and Quantity Concepts in Assessing Food." Food Product Development, 7 (April, 1973), pp. 57-62.

The term "utilizable protein" emphasizes nutritive quality as well as protein quantity. A review of the common bioassays for protein quality is given and several tables showing relative nutritive value and utilizable protein in various sources are included, along with estimates of cost-effectiveness in terms of utilizable protein.

133. Daniel Rosenfield. "Feeding Children Through U.S.D.A. Programs." Food Technology, 27 (August, 1973), pp. 36-38.

Over 40 million school children participate in Child Food Service Programs. A new meal standard expressed in nutrients is being studied as a possible alternative to Type A lunch for feeding school children. The FNS now recognizes formulated grain-fruit products, TVP, protein-fortified macaroni, and cup-can as acceptable for use in school feeding. Problems concerning the use of new foods are discussed.

134. Virginia Ross. "Soy-Whey-Milk Offers Economic Substitute for Frozen Whole Milk Concentrate." Quick Frozen Foods, 34 (April, 1972), p. 100.

A research team at the University of Illinois has developed a flavorless soy-whey-milk that can be processed from whole soy beans to do away with any bad taste. Boiling the beans neutralizes the enzyme that causes bad flavor. The milk is said to taste like a milk shake or egg nog when flavoring is added, and is cheaper than milk, although not more nutritious.

135. Dorothy Rowe; George Mountney and Inez Prudent. "Effect of Freeze-Drying on the Thiamin, Riboflavin, and Niacin Content of Chicken Muscle." Food Technology, 17 (November, 1963), p. 1449.

Chicken muscle cubes subjected to freeze drying showed no loss of thiamin, riboflavin, or niacin that could be attributed to the dehydration process. Samples precooked before freeze drying showed a loss of thiamin only. Thiamin and riboflavin content was greater in dark meat than in light, and niacin content was less.

136. H. Sanstadt. "Textured Vegetable Proteins . . . Solution to Institutional Dietary Problems?" Cooking for Profit, 41 (March, 1972), pp. 21-26, 36, 39.

The food service department of the Lynchburg Training School and Hospital uses textured vegetable protein products at the rate of 10,000 pounds per month. The use of TVP is responsible for a 30-percent savings in the purchase of protein foods. These foods also play an important role in the dietary needs of patients, providing amino acids equal to that of animal proteins, but containing no cholesterol.

136a. M. L. Rakieten; B. Newman; K. G. Falk and I. Miller. "Comparison of Some Constituents in Fresh Frozen and Freshly Squeezed Orange Juice II." J.A.D.A., 28 (November, 1952), pp. 1050-1053.

Ten samples of fresh-frozen reconstituted orange juice were compared with samples of freshly squeezed orange juice. The following constituents were found to be in approximately the same concentrations in both types: thiamin, riboflavin, para-aminobenzoic acid, niacin, choline, biotin, phosphorus, magnesium, and sulphur. Calcium values appeared higher in freshly squeezed juice. Mean values of iodine, manganese, potassium, vitamin A and vitamin B_{12} were higher in fresh frozen than freshly squeezed juice.

137. Elizabeth Ann Schiller; Dan E. Pratt and Ellwood Reber. "Lipid Changes in Egg Yolks and Cakes Baked in Microwave Ovens." J.A.D.A., 62 (May, 1973), pp. 529-533.

Lipids extracted from egg yolk samples heated by conventional and microwave heating exhibited no changes in fatty acid composition and no measurable decrease in polyunsaturated fatty acids as a result of heat treatment. Cakes baked in conventional and microwave ovens were analyzed and it was found that oxidation levels were significantly higher in cakes baked in the microwave oven than in cakes baked in the conventional oven.

138. Henry A. Schroeder. "Losses of Vitamins and Trace Minerals Resulting from Processing and Preservation of Foods." American Journal of Clinical Nutrition, 24 (May, 1971), pp. 562-573.

Data on the concentrations of vitamin B_6, pantothenic acid, other vitamins and trace minerals in raw and frozen, processed, refined, or canned foods have been evaluated in the light of probable human requirements and recommended allowances. It is suggested that enrichment of refined flour, sugar, and fats may be necessary, especially to meet daily recommendations of vitamin B_6, pantothenic acid, chromium, zinc, and possibly manganese.

139. Virginia Sidwell and Bruce Stillings. "Crackers Fortified with Fish Protein Concentrate (FPC): Nutritional Quality, Sensory, and Physical Characteristics." J.A.D.A., 61 (September, 1972) pp. 276-279.

In this study up to 16 percent of the flour used in saltine-type crackers was replaced by high-protein fish protein concentrate (FPC). Fortification levels of 4 and 8 percent FPC increased PER threefold or more; higher fortification did not improve nutritional quality. Crackers with 4 and 8 percent FPC were as acceptable as unfortified crackers in texture and flavor.

140. Nancy Snider. "Artificial vs. Real Sweetners." Institutions, 65 (December, 1969), p. 16.

The reasoning behind the struggle to remove cyclemates from the market is refuted.

141. Nancy Snider. "Convenience Food Reports." Institutions, 69 (October 15, 1971), p. 97.

Cottonseed can be a source of three major classes of protein products: defatted flour, protein concentrates, and protein isolates. A newly developed "liquid cyclone process" allows cottonseed flour to be manufactured at a cost of about 10¢ per pound. The protein content is from 67 to 70 percent, the flour is concentrated, has a bland taste, and is light cream in color.

142. Nancy Snider. "Fats." Institutions, 69 (November, 1971), p. 83.

The nature of different types of fats and their relationship to heart and artery disease is discussed. The author draws the conclusions that it is not only fat that causes problems but how much is eaten and what other foods are in the diet, as well as the individual's metabolism.

143. Nancy Snider. "Of Concern." Institutions, 69 (December, 1971), p. 33.

Because of the discovery of DES in beef liver samples, federal regulations now prohibit feeding this hormone for seven days before slaughter. According to one source, if DES were banned completely, meat prices might rise as much as 5 percent.

144. Nancy Snider. "Nutrition and Food Safety Puzzle." Institutions, 70 (May 15, 1972), pp. 33-34.

Seminars on labeling, nutrition education, nutrition and public policy, malnutrition, food scientists, food chemicals, and information costs to consumers are reviewed.

145. Nancy Snider. "Convenience Food Report." Institutions, 70 (April 15, 1972), p. 105.

Dr. George Briggs feels poor nutrition is due to 6 factors: (1) economics, (2) negative social and cultural customs, (3) negative food industry factors, (4) lack of education, (5) lack of motivation, and (6) lack of nutrition education. He feels we must keep eating "traditional" foods to obtain our nutrients.

146. Nancy Snider. "Convenience Food Report." Institutions, 70 (May 1, 1972), p. 149.

This is a review of recent FDA action on nutritional standards with emphasis on comments about the new voluntary nutritional labeling.

147. Nancy Snider. "Operators Inside Look at Nutrition and Food Service." Institutions, 72 (January 15, 1973), pp. 45-55.

Included is a question and answer section with Dr. Jean Mayer about nutritional requirements and how the food service companies can help consumers be more aware of them.

148. James Snyder. "Profits in Protein?" Fast Food, 71 (July, 1972), pp. 36-40.

The article provides reasons why restauranteurs should take notice of the nutrition trend. The value of food, the public's changing eating habits, the institutional market, and food quality are also addressed. Most food manufacturers strongly agree that more nutrient information should be given the consumer, but they complain that the FDA's proposed guidelines for nutritional labeling are confusing and unworkable.

149. James Snyder. "Lawmakers Zero in on Vegetable Protein." Fast Food, 72 (July, 1973), pp. 40-44.

The grocery industry has recently been issued proposed federal regulations concerning engineered foods, their labeling, and composition. The purpose of the regulations is to allow manufacturers to innovate products, but protect the consumers' right to know what he is eating. Regulations are described and state requirements are given for the labeling of hamburger.

150. Ira I. Somers. "Quality Control Problems in Nutritional Labeling." Food Drug Cosmetic Law Journal, 27 (May, 1972), pp. 287-297.

There are many unresolved problems involved in the production of labels with accurate, informative nutritional data. Quality control problems created by nutritional labeling generally have to do with three categories of food products: (1) fabricated products manufactured from ingredients with partially controlled nutrient contents, (2) products consisting of combinations of different foods, and (3) unformulated products processed as harvested. Nutritional analyses on individual food products have prohibitively high costs. The author advocates the use of average values of nutrients available to the consumer, rather than specific values, which are more costly.

151. Raymond Stokes. "The Consumer Research Institute's Nutrient Labeling Research Program." Food Drug Cosmetic Law Journal, 27 (May, 1972), pp. 249-262.

Results are reported of studies (complete with statistics) of nutritionists' opinions on nutrient labeling and label space priorities, consumers' opinions on nutrient labeling, consumers' attitudes and knowledge of nutrition, and the relation of nutrient information and food purchasing behavior.

152. Lonnie Speight. "The Systems Concept--A New Path to Menu Planning." Institutions, 66 (April, 1970), pp. 43-46.

The systems concept is a unique approach to management, a way of organizing for accomplishing tasks. Application of systems approach to menu planning is discussed.

153. Joseph M. Stewart. "How Can You Make Them Eat the Nutrition You Serve?" Institutions, 73 (August 1, 1973), pp. 10-12.

Providing a nutritious school lunch is a logistical problem; consumption of the meal is both a social and psychological problem. Affluent Americans may not take the time to consume adequate meals, and the less affluent may be forced, for economic reasons, to consume overly starchy, fatty, or other inadequate diets. Dietary inadequacy carries over to the children and their reaction to the school lunch. A nutrition education program directed at both parent and child is needed.

154. J. P. Sweeney and A. C. Marsh. "Effect of Processing on Provitamin A in Vegetables." J.A.D.A., 59 (September, 1971), pp. 238-243.

Carotene isomers were found in freshly harvested vegetables. Processing procedures (cooking with and without pressure, freezing, canning, and in some cases freeze drying) converted additional amounts of all-trans carotene to stero-isomers with lower biopotency values.

155. Barry Tarshis. "School Lunch: The Problem is Management." Institutions, 65 (July, 1969), pp. 46-52, 58.

This report from the N.Y. State Food Service Association states that school lunch people know enough about food and nutrition but must concentrate on total management. Inadequate nutrition is not just a problem of lower income communities, but can exist in wealthier communities where school food service has a low priority.

156. L. J. Teply and F. H. Derse. "Nutrients in Cooked Frozen Vegetables." J.A.D.A., 34 (August, 1958), pp. 836-840.

Twenty frozen vegetable products were subjected to cooking procedures which involved the use of minimal amounts of water and cooking to subjectively determine "Optimum flavor doneness." There was little leaching of nutrients into the water except for small amounts of sodium and approximately 1/4 of all the vitamins, except beta-carotene in turnip greens. Overall, there was practically complete retention of thiamin, niacin, and riboflavin. Ascorbic acid, too, was well retained.

157. Frank Thomas. "Management Perspectives." Institutions, 62 (May, 1968), p. 221.

People's tastes are conditioned by what they are accustomed to. A trend toward more bland foods is evolving among young people. Today's economic climate indicates that more non-animal foods will be used and protein substitutes will probably wean people away from red meat in general.

158. M. H. Thomas; S. Brenner; A. Eaton and V. Craig. "Effect of Electronic Cooking on Nutritive Values." J.A.D.A., 25 (January, 1949), pp. 39-45.

The amount of cooking water used had the greatest influence on the retention of water soluble nutrients in vegetables. Pressure cooking resulted in superior retention compared to boiling water and electronic range techniques. Thiamin retention was higher in meat patties cooked by high frequency energy than in patties cooked by grilling. Beef roasts showed slightly better retention of thiamin , riboflavin, and niacin when prepared in a conventional oven than when prepared in the electronic range.

159. Miriam Thomas and Doris Calloway. "Nutritive Value of Irradiated Turkey." J.A.D.A., 33 (October, 1957), pp. 1030-1033.

Thiamin content was severely reduced during irradiation, destruction increasing with the dose of irradiation. Riboflavin was more resistant to radiation and niacin was not affected. After roasting, thiamin retention in irradiated turkey was less than in non-irradiated. There was no difference in riboflavin, and niacin retention was slightly less after cooking. Pan drippings showed that only thiamin was destroyed by heat, as all riboflavin and niacin losses were recovered in the drippings.

160. Miriam H. Thomas and Doris H. Calloway. "Nutritional Value of Dehydrated Food." J.A.D.A., 39 (August, 1961), pp. 105-116.

A comparison was made of the nutrient content of various animal and vegetable products before and after dehydration, irradiation, and the conventional thermal processing. Generally, the results suggest that nutrient content is affected least by dehydration.

161. W. S. Tsien and Connor Johnson. "The Effect of Radiation Sterilization on the Nutritive Value of Foods." Journal of Nutrition, 69 (September, 1959), pp. 45-48.

The effect of irradiation at 2.8 million, 5.6 million, and 9.3 million rad. levels on milk and beef were studied. It was found that glutamic acid, aspartic acid, serine, and glycine were most seriously reduced by irradiation in both milk and beef.

162. U.S. Agricultural Research Service. "Conserving the Nutritive Values in Foods." Home and Garden Bulletin No. 90 (Washington, D.C.: 1968).

This bulletin calls attention to some of the important nutrients in foods that are affected by different practices of handling and preparation, and suggests ways in which these nutrients can best be conserved in the home. Such information affords guidelines for meal planning and preparation that will assure overall adequacy of the diet while allowing for individual preferences in the selection of foods and the form in which they are served.

163. Helen VanZante and Shirley Johnson. "Effect of Electronic Cookery on Thiamin and Riboflavin in Buffered Solutions." J.A.D.A., 56 (February, 1970), pp. 133-135.

The effects of electronic cookery on thiamin and riboflavin in buffered aqueous solutions were investigated by microbiologic and spectrophotometric analyses at two levels of concentration and two final internal temperatures. Both methods of vitamin analyses indicated slightly higher thiamin and riboflavin retention during conventional electric heating than electronic heating. The retention differences were small and of little significance.

164. H. R. Vernon. "Non-Dairy Cheese--A Unique Reality." Food Product Development, 6 (August-September, 1972), pp. 22-26.

A satisfactory replacement for natural cheese must provide fats, protein, vitamins, minerals, and essential amino acids in the same approximate amounts that natural cheese provides. A successful substitute has been formulated and is marketed as "Unique Loaf." The product composition, consistency, flavor, keeping qualities nutritional aspects, reliability of supply, and handling during manufacturing are discussed.

165. F. Voirol. "The Blanching of Vegetables and Fruits." Food Processing Industry, 41 (August, 1972), pp. 27-33.

Of three blanching methods, immersion in water allows water soluble nutrients to pass into the blanching water, but this method also controls undesirable oxidation. Immersion in steam and treatment with microwaves conserve nutrients, but are technically more difficult to control because they require specialized apparatus. Enzymatic browning can be prevented by adding vitamin C; when sulphur dioxide is used to prevent browning it may cause corrosion and off-flavors, it can destroy vitamin B_1, and it can be hazardous to health at high levels.

166. Jane Wallace; Audrey Garvey and Julie Woodman. "Convenience . . . and Beyond." Institutions, 64 (April, 1969), p. 95.

Proteins produced by fermentation of petroleum are rich in B vitamins and a number of amino acids. They show a digestability of from 85 to 90 percent. The efficiency of converting hydrocarbons to yeast is 1 kilogram of hydrocarbons = 1 kilogram of yeast. Yeast produced from oil has no pronounced odor or taste and is relatively cheap, stable, and easily transported.

167. Jane Wallace; Audrey Garvey and Julie Woodman. "Convenience . . . and Beyond." Institutions, 64 (April, 1969), p. 96.

The authors provide a partial listing of some common weeds and grasses which may be cultivated to vary the menus of the future. The article describes the weeds and occasionally mentions good sources of vitamin A and C, and minerals.

168. Jane Wallace. "Tomorrow: Two Chickens in Every Pot--and a Soy Burger on Every Bun." Institutions, 66 (April, 1970), p. 90.

Inflation and the stringent economics of beef production reduce the prospects of steak being consumed in as high quantities as in previous years. Hamburger (and possibly hamburger mixed with soy protein) will be used instead. Soy protein (with beef) makes a larger and juicer burger, with a higher nutritional value than is available with beef alone. Americans may be slow to accept soy protein extenders, but their attitude may be altered by the pressure of cost of pure beef, a new emphasis on nutrition as preventive medicine, and nutrition as a political issue.

169. Jane Wallace. "Is it Our Turn in the Bag? The World of Service." Institutions, 67 (October, 1970), p. 11.

There is rising concern about nutrition and the effect it could have on the food service industry. Many accusations (about cyclamates, MSG, and empty-calorie cereals) are exaggerated or unjustified and the public is confused about what to believe. Companies that prepare now for possible attacks which may come will fare best during the time the "nutrition cause" is in fashion.

170. Jane Wallace. "Soy Helps Hold Down Costs." Institutions, 67 (October, 1970), p. 140.

The article discusses new food developments (specifically soy protein) which help offset increased costs of traditional foodstuffs. It also gives advice on the use of soy protein.

171. Jane Wallace. "Something is Not Always Better Than Nothing. Service World Report." Institutions, 68 (January 15, 1971), p. 11.

Nutrition does not mean that people must be forced to eat foods they don't like. Food not eaten is worthless. People must not confuse "nutritious" food with "pure" food.

172. Jane Wallace. "Discrimination Because of Age?" Institutions, 68 (April 15, 1971), p. 11.

Efforts are being made to help solve the nutritional problems of the elderly. Examples are Meals on Wheels, Foster grandparent programs, A.D.A.'s position paper on the elderly, reduced cost menus for the elderly in some restaurants, and the suggestion that food stamps be used to buy prepared meals for the elderly.

173. Jane Wallace. "The World of Service." Institutions, 70 (April 15, 1972), p. 13.

This editorial suggests ways the restaurant industry could help dieters.

174. Jane Wallace. "What's in a Name?" Institutions, 70 (June 1, 1972), p. 11.

The need for more nutrition education is emphasized. Dietitians are criticized for keeping "professional secrets" and not disseminating vital nutrition information.

175. Jane Wallace. "The World of Service." Institutions, 72 (May 1, 1973), p. 11.

This editorial criticizes FDA's labeling regulations for food service products.

176. Jeremiah Wanderstock. "Food Analogs." Cornell Hotel and Restaurant Quarterly, 9 (August, 1968), pp. 29-33.

Many different food analogs are commercially available--dairy product substitutes, fruits and vegetables, flavors, sweeteners, and high energy foods. The use of spun protein foods has been implemented to serve as additives to ground meats and in dietary and religious areas.

177. J. Weits; M. A. VanderMeer; J. B. Lassche; J. C. Meyer; E. Steinbuch and L. Gersons. "Nutritive Value and Organoleptic Properties of Three Vegetables Fresh and Preserved in Six Different Ways." Internationale Zeitschrift fur Vitaminforschung, 40 (1970), pp. 648-658.

Spinach, garden peas, and green beans were prepared by bottling, canning, domestic and commercial deep freezing, dehydration and freeze drying and were stored for six months. Vitamin C content was lowest in bottled and dehydrated vegetables, and highest in freeze dried and commercial deep frozen vegetables. Thiamin levels were generally higher than vitamin C levels. The best thiamine retention occurred in dehydrated and freeze dried vegetables; the poorest retention was evidenced in canned vegetables.

178. R. W. Wing and A. Alexander. "Effect of Microwave Heating on Vitamin B_6 Retention in Chicken." J.A.D.A., 61 (December, 1972), pp. 661-664.

In this study, chicken breasts were cooked by microwave and in a conventional oven. Retention of vitamin B_6 in the microwave-cooked samples was significantly higher than the conventionally cooked. Microwave cooking resulted in greater weight loss and less moisture retention than conventional roasting.

179. Paul Dudley White. "How to Extend Your Life Span." Institutions, 65 (September, 1969), pp. 105, 108, 110, 114, 116.

Preventions and control of heart and artery diseases are discussed. Risk factors are stressed and are classified as uncontrollable or controllable. The article list practical points to follow which will increase longevity, with an emphasis on moderate changes.

180. Virgil Wodicka. "FDA's Omnibus Labeling Proposals--an Overview." Food Technology, 27 (April, 1973). pp. 52-62.

This article presents a brief review of the third phase of FDA's program of nutrient labeling, published in 1973. Comments about the new system, as expressed by leading members of the food industry, are included.

181. Julie Woodman. "Service World Week." Institutions, 70 (April 1, 1972), pp. 17-18.

Research now points to heredity as the cause of an inability to cope with excess cholesterol. The USDA is now looking into the effect Type A requirements are having on teenage male's cholesterol levels.

182. Julie Woodman. "Nutrition--Steaks Guilty by Association?" Institutions, 70 (March 15, 1972), p. 18.

There have been reports that the saturated fats that tend to raise cholesterol levels are not found in meat.

183. Julie Woodman. "Food Revolt on Campus." Institutions, 70 (January 15, 1972), p. 17.

College students have become more food and weight concious and they have started to rebel against establishment food. College food service departments are trying to implement new varieties and types of foods to correspond to these new food habits.

184. Agnes R. Yates. "Dieting and Eating Out: Letters to the Editor." Institutions, 68 (February 1,1971), p. 12.

The writer questions why restaurants do not include smaller portions on menus, why vegetables in cooking bags are not more widely used, and why sources of vitamin C are so high priced in restaurants. It is stated that the food industry could have a dynamic effect on the promotion of nutrition.

185. Mary Zehner. "Nutritional Labeling as Viewed by Michigan Panel." Department of Agricultural Economics, Michigan State University (no date available).

1,972 panelists evaluated the unit, percent, and descriptive methods of nutritional labeling. The unit method was preferred over the descriptive method for comparing nutritional values of pork and beans, while the percent method was favored for canned peaches. A favorable reaction was received for the descriptive method for comparing nutritive values of foods, especially sources of protein. The panelists most wanted nutritional information on the labels of bread and cereal products, dairy products, and canned meats and fish. Generalizations and recommendations concerning the study are given.

V

PLANNING ASPECTS AFFECTING THE FUTURE OF FOOD SERVICE:

A STUDY OF PLANNING AND SPATIAL ISSUES

by

Eugene J. Bazan, Ph.D.,

Jack L. Nasar,

and

Lawrence A. Swanson

PLANNING ASPECTS AFFECTING THE FUTURE OF FOOD SERVICE:

A STUDY OF PLANNING AND SPATIAL ISSUE

Structure of Population

Introduction

This report investigates a number of factors that affect food services. As an economic sector, the many firms comprising food service respond to a multitude of demographic forces and life-style patterns. These reflect the processes of urbanization, suburbanization, movements to rural areas, income patterns, leisure time and work activity, and migration patterns--both daily and secular.

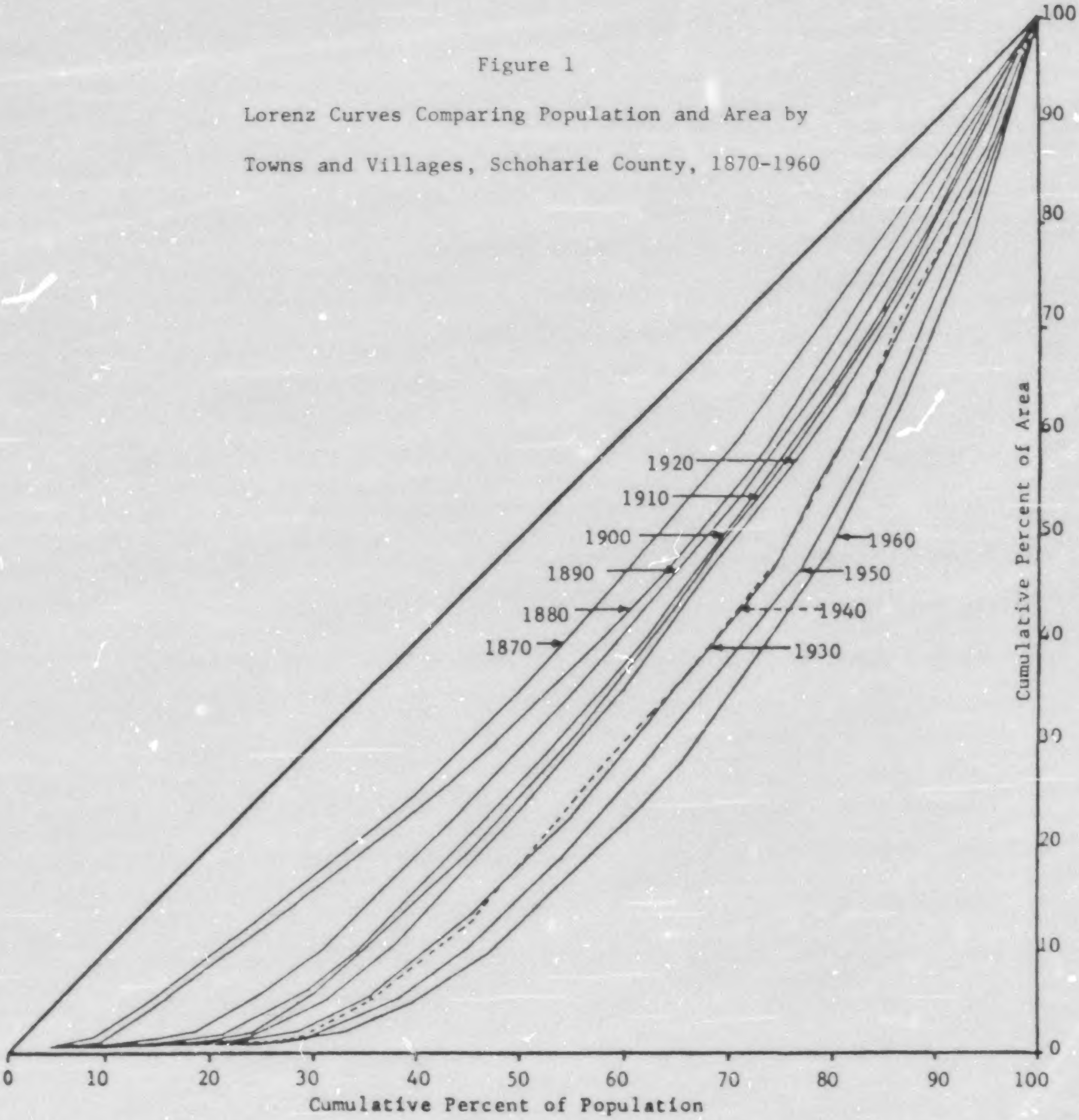
At the same time, and by responding to these forces, food services themselves establish patterns of behavior internal to the industry, in terms of capital structure, firm size, market areas covered, employment patterns, and location. These patterns ultimately affect the population system, as they create demands and supplies for resources and personnel.

Although it is our purpose to define alternative configurations for selected attributes of the food services sector, we limit ourselves for the present to describing the interrelationships between the population system and the food services. Our comments pertain at first to the country as a whole, but later analysis will focus more directly on the State of Pennsylvania.

Figure 1

Lorenz Curves Comparing Population and Area by

Towns and Villages, Schoharie County, 1870-1960



Source: Barclay G. Jones, Richard L. Ragatz, and Phaichitr Uathavikul, Regional Analysis For Economic Development: A Demonstration Study of Schoharie County, N.Y., Division of Urban Studies, Center For Housing and Environmental Studies, Cornell Univ., Ithaca, N.Y., Sept. 1964.

Structure of Population Patterns

A number of historical patterns have been identified for describing population systems in the aggregate. These patterns reflect the degree of concentration of the population on smaller and smaller land areas. Such patterns as those illustrated by the Lorenz curves in Figure 1 are common to many parts of the country and reflect urbanization--the movement of the population from rural to urban areas (40).

Mathematically, the Lorenz curves record only what we already know--that more and more people are living in fewer and fewer places. What is particularly interesting about the relationship of people to places, however, is that the places themselves are ranked by size according to still another mathematical function, shown in Figure 2.

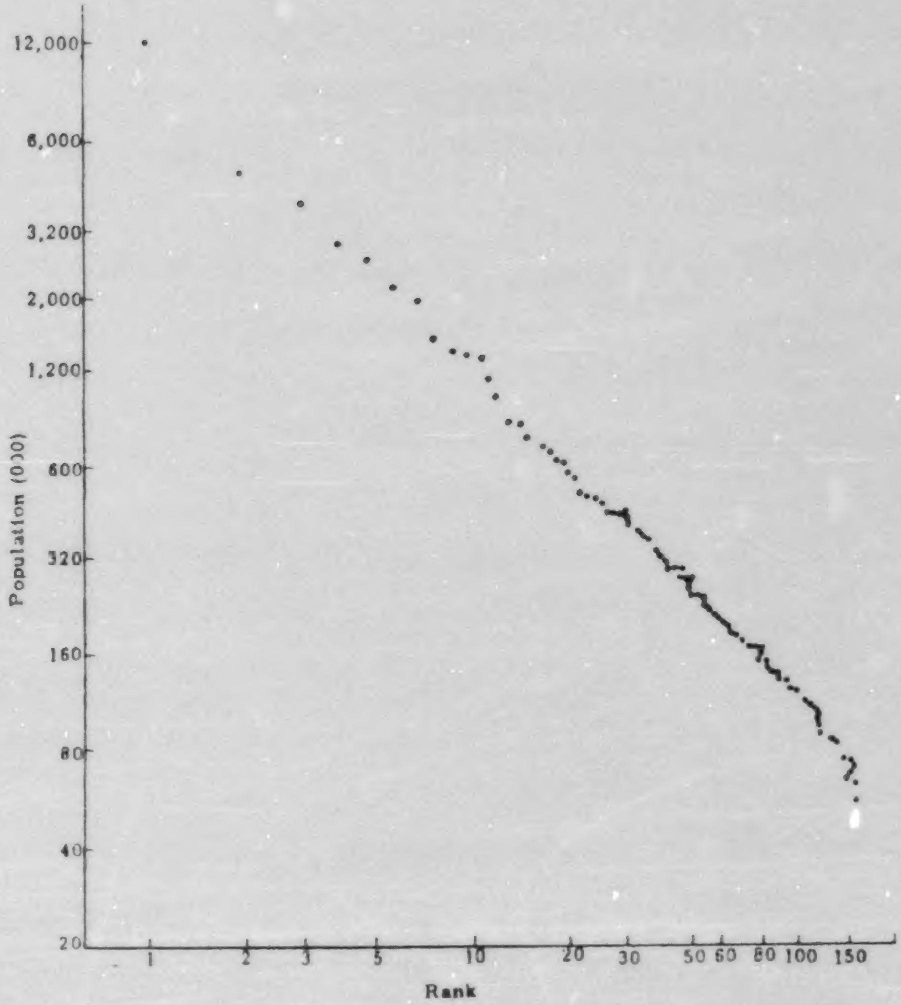
This relationship is best known as the "rank-size rule." It states simply that, given a city of rank 1 (New York) with 12,000,000 people, the next largest city (rank 2) will have a population 1/2 that of New York (6,000,000), the next largest city (rank 3) will have a population 1/3 that of New York (4,000,000), and so on. The result is a straight line when plotted on log paper. This pattern has persisted over time (Figure 3) and for a number of countries throughout the world (Figure 4).

Were these patterns to be limited to just urban systems, we might consider them "interesting" but not particularly relevant to the topic of food service establishments. A number of other studies, however, have confirmed similar patterns for various other economic sectors like manufacturing (Figure 5) and retail (Figure 6).

The rank-size rule is a special case of the lognormal distribution,

Figure 2

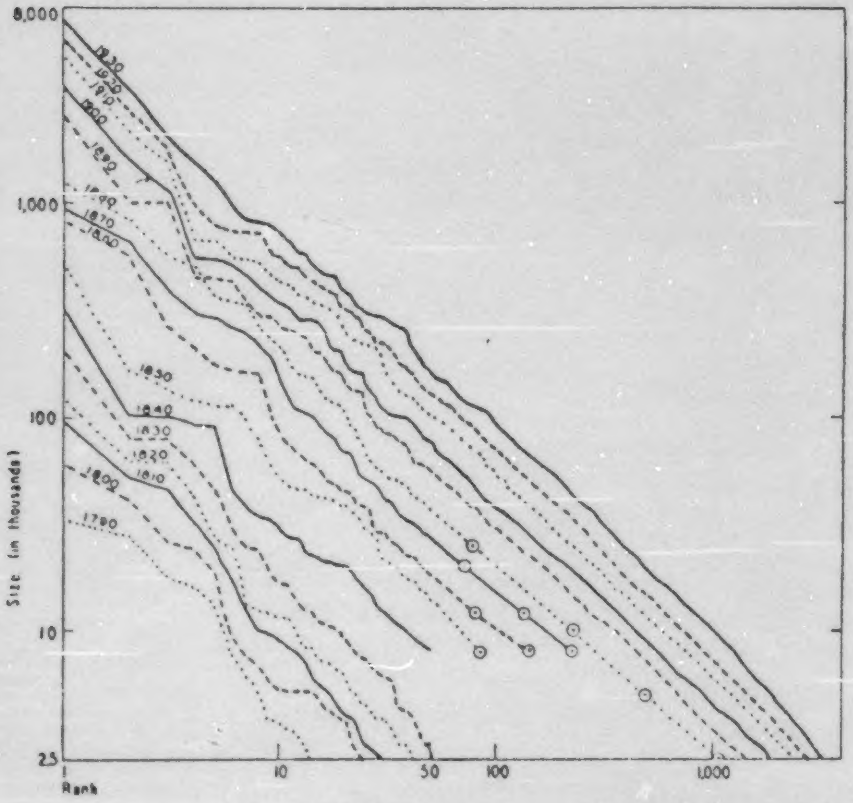
Population of Urbanized Areas Ranked by Size, 1950



Source: D. Rutledge Vining, "A Description of Certain Spatial Aspects of An Economic System," Economic Development and Cultural Change, vol. III, no. 2 (January 1955), pp. 147-195.

Figure 3

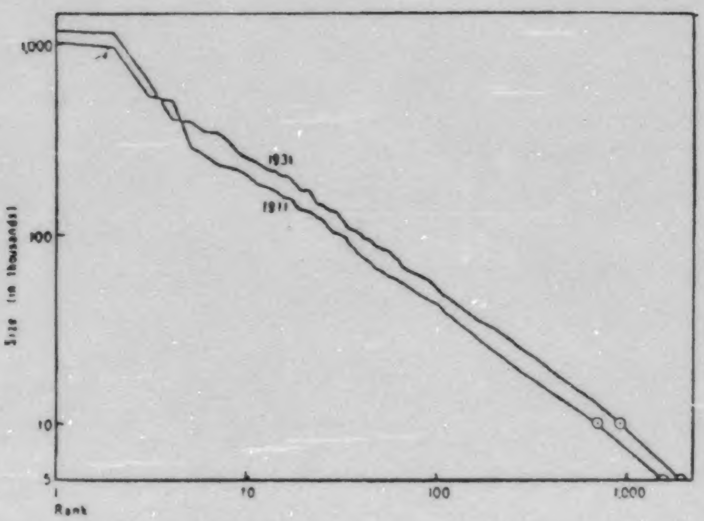
U.S.A. 1790-1930. Communities of 2500 or More Inhabitants Ranked in the Decreasing Order of Population Size



Source: George Kingsley Zipf, Human Behavior and the Principle of Least Effort (Cambridege: Addison-Wesley Press, 1949).

Figure 4

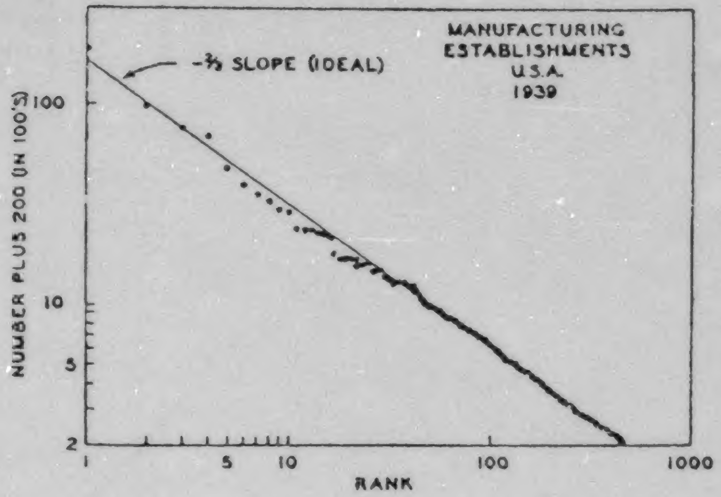
India in 1911 and 1931. Communities Ranked in the Decreasing Order of Population Size.



Source: George Kingsley Zipg, Human Behavior and the Principle of Least Effort (Cambridge: Addison-Wesley Press, 1949).

Figure 5

Manufactures in the U.S.A. in 1939 When Ranked in the Order of the Decreasing Number of Manufactures of Like Kind.

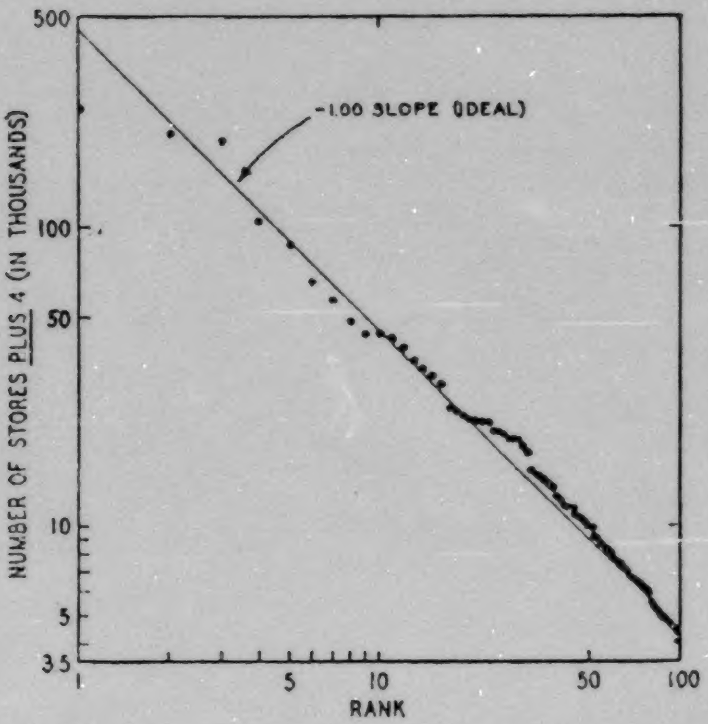


Source: George Kingsley Zipf, *Human Behavior and the Principle of Least Effort* (Cambride: Addison-Wesley Press, 1949).

Figure 6

Retail Stores (including Chain Stores) in the U.S.A. in 1939,

Ranked in the Order of Decreasing Number of Stores of Like Kind

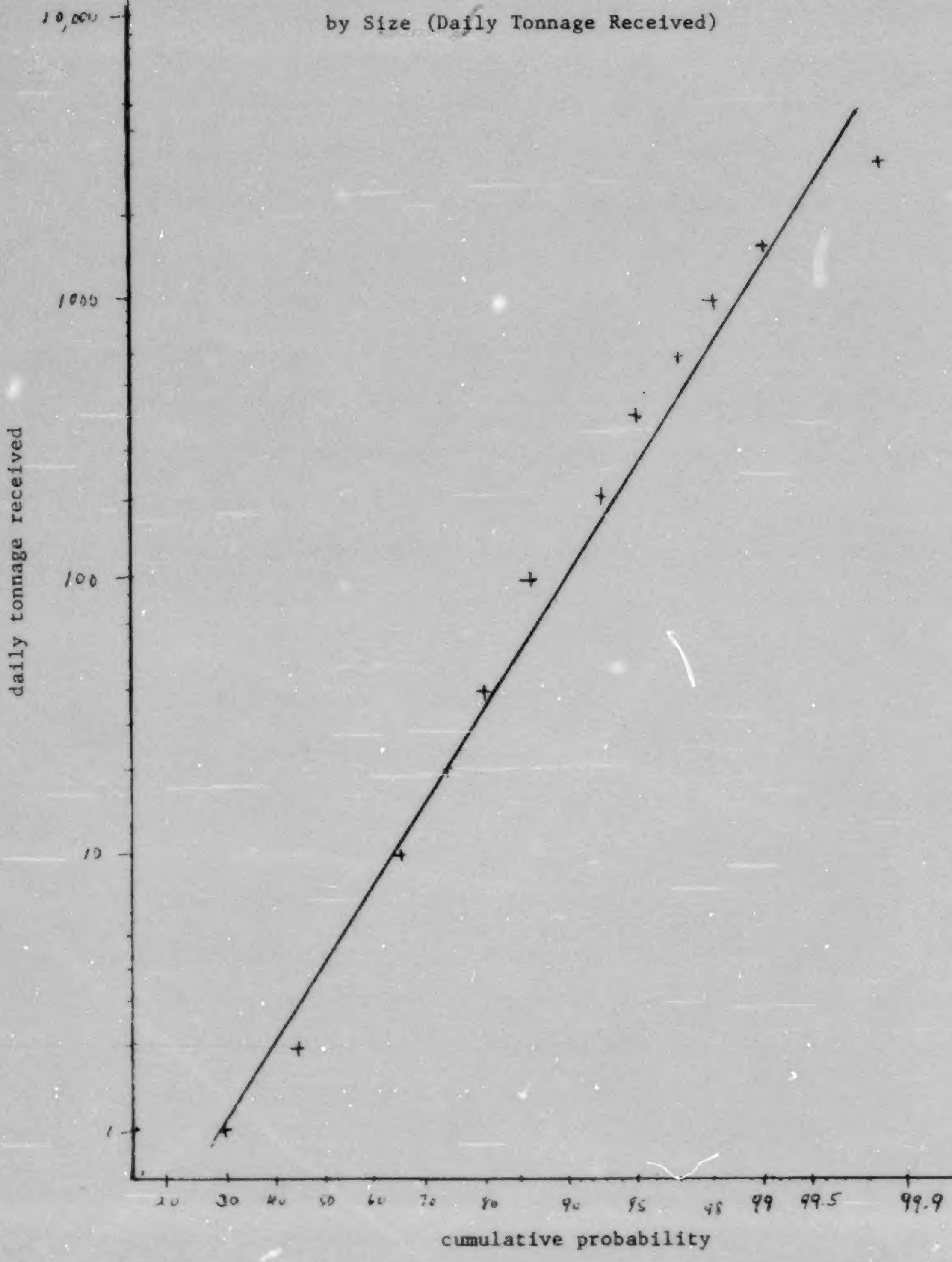


Source: George Kinglsey Zipf, Human Behavior and the Principle of Least Effort (Cambridge: Addison-Wesley Press, 1949).

Figure 7

Log-normal Distribution of California Disposal Sites

by Size (Daily Tonnage Received)



one of a general class of skewed distributions. Recent theoretical developments in the field of regional science suggest that the patterns underlying the lognormal distribution can be produced by a simple population growth process (58). Migration is admissable in this model under certain assumptions; although birth is not admissable, its inclusion does not seem to alter results drastically (9).

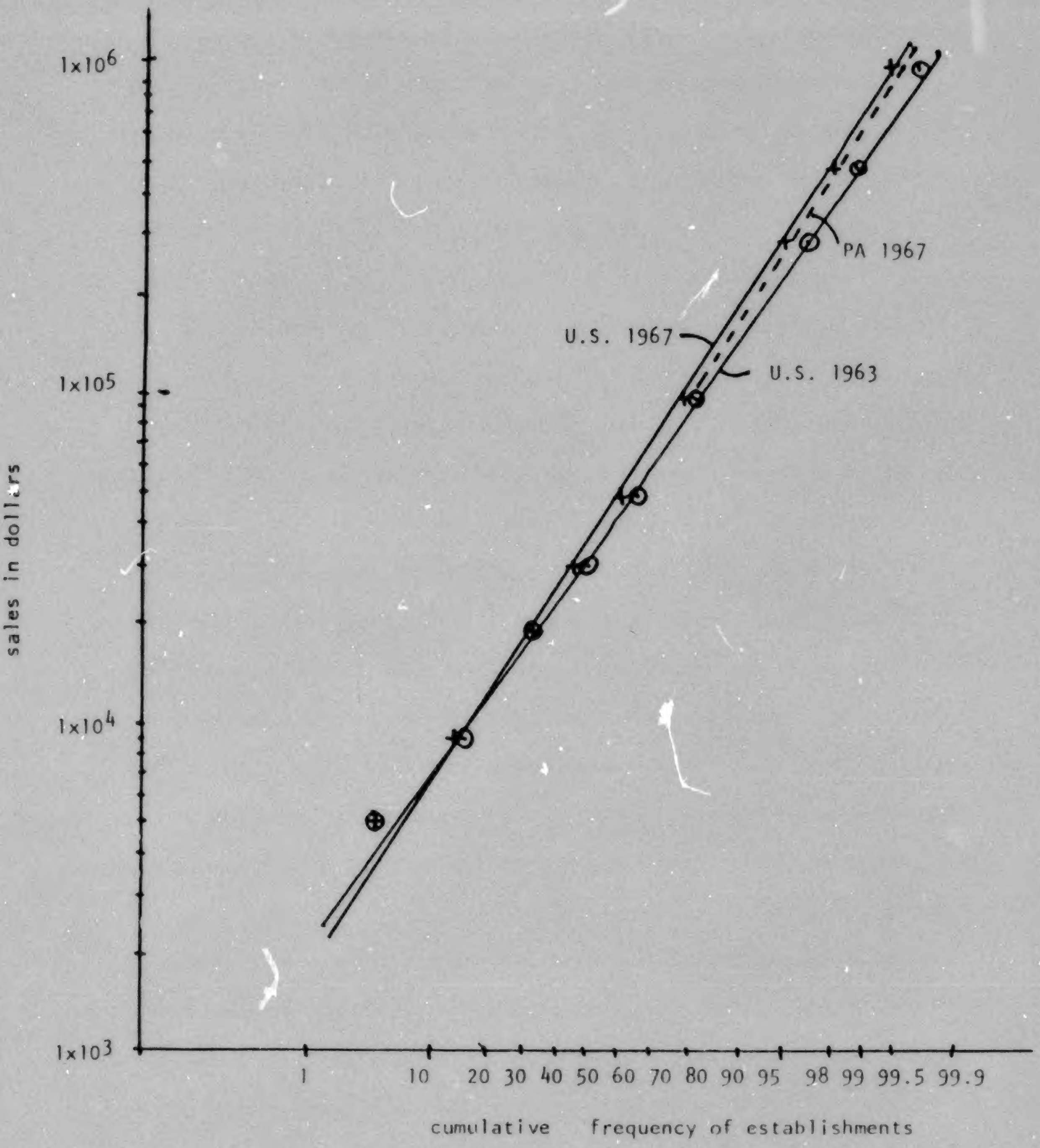
Thus, we have a simple model that explains, in terms of process variables we know all about (birth, growth, and migration), the structure of urban population systems. The model is also applicable to any population or population-related system having similar characteristics, such as retail trade or manufacturing or even garbage dumps (Figure 7). A look at the distribution of establishments in the food services sector, as shown in Figure 8, confirms the model for still another economic activity.

In addition to distributions displaying relative size, we are also interested in the relative location of units in space. Spatial economic theory describes why market goods arrange themselves in hexagonal market areas (39). The overlap of market areas for different market goods leads to a hierarchy of urban places. This hierarchy is similar to the one displayed by the lognormal distribution (8).

Food services can easily be categorized as a market good of this type. This simply means that consumers will not travel beyond a certain distance to obtain food services of a given quality. Sellers of this service will then divide the space so as to exhaust the market. The indication by many of the larger chains that they build new units to accommodate a certain volume and that this volume is based primarily

Figure 8

Distribution of Food Service Establishments



Source: U.S. Census of Business, Retail Trade Subject Reports, Vol. 1 Table 1 and Table 3.

on neighborhood patronage, supports this contention. A market region so divided will look like the one shown in Figure 9.

The extent and interrelationships of these markets will vary, depending upon the internal functional structure of the city. In general, however, we can expect relationships like those shown in Figure 10 to prevail (43, 60). For the food services sector in a city of 100,000 people, 90 percent of the food services will be found downtown in the core city, whereas the balance, 10 percent, will be found outside the core city in suburban locations. As the city size increases, and the suburban character of the place prevails, more of the food services will be found in non-core locations. For example, in a city of 400,000, only 15 percent of the food services will be found in the core area, whereas 85 percent will be found in non-core or suburban areas.

From a spatial market standpoint, we can expect to find the hexagonal markets of the food service establishments tightly packed in the first instance and more loosely packed in the second. In general, for a typical city, the spatial market areas will exist on a gradient from very small areas near the center to very large market areas in the suburban areas (39). This reflects nothing but differences in customer density.

One important factor that distorts the patterns just described above is the effect of commercial ribbons of retail and service facilities (11, 16). Whereas the hierarchic market area approach establishes a "hinterland" around each center, the commercial ribbon really acts as a linear market depending on traffic flow through it. A number of studies have demonstrated the variability of these commercial strips.

FIGURE 9

A Divided Market Region

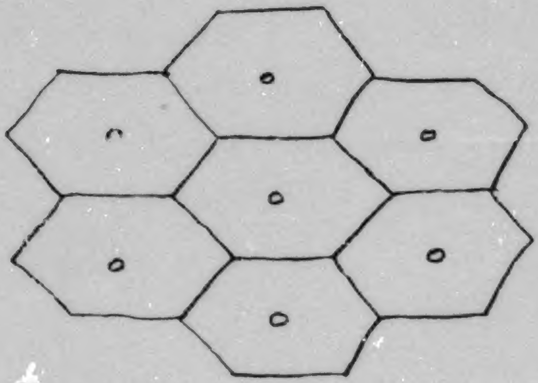
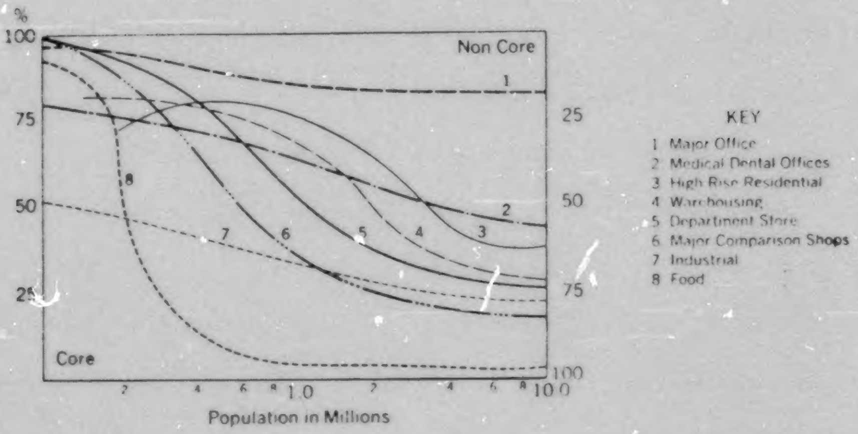


FIGURE 10

Market Region Relationships



Source: Larry Smith, "Space For the CBD's Functions," in Bourne, Internal Structure of the City (London: Oxford University Press, 1971), chart I, p. 358.

Even within the food service sectors, differences between restaurants and drive-in eating places exist on commercial strips. For example, people tend to make a special trip to a restaurant on a commercial strip, but combine a stop at a drive-in with other stops on the commercial strip. Drive-ins, then, capture much more of the major through-traffic than restaurants. Thus, food service establishments reveal both a hierarchic and a highway service orientation, even when located along commercial ribbons.

Trends in Population Patterns

The geographic patterns of population movements can be organized for analysis into three functional streams (51). The first deals with the movements of people from economically depressed areas of the nation to more viable areas. In the past, this movement has primarily constituted migration from rural to urban areas. But due to changes in the structure of many local economies, movements of this type will increasingly take place between urban areas. The second functional stream consists of movements within metropolitan areas (21, 62). Due to changing life styles, incomes, and family sizes, people may move to different parts of the same metropolitan area, but may not change their job or type of work. The third functional stream consists of movements between metropolitan areas (42). These movements are typically related to changes in job or position within a company, a drastic change in life style, or a desire to start new elsewhere. These migration patterns, in contrast to birth patterns, will be the shapers of urban structural change.

In particular, examination of growth patterns reveals that spontaneous growth centers are acquiring a disproportionate share of redistributed growth (51). A large share of the growth in metropolitan areas in general occurs through immigration by a relatively few, rapidly growing metropolitan centers. Future urban growth is likely to be concentrated in these relatively few "migration magnets" (27). Because of these shifting patterns, a number of existing metropolitan areas can be expected to level off and even decline in population during the late 1970's. Moreover, this development will have implications for metropolitan markets in general, and food services among them. In particular, the food service sector can expect to find rapidly growing markets and opportunities in small, rapidly growing metropolitan areas. These are characterized by a younger, more mobile demographic profile, and therefore a profile that is more likely to demand higher levels of urban eating services and leisure facilities.

These general patterns obscure variations in migration patterns among groups. For example, Blacks appear to move more often than Whites, reflecting in part their renter status and concomitant inability to obtain loans or accumulate capital for a house and their inability to break into suburban areas (30). The prosperous and highly educated move to the suburbs while the poor stay in the cities; this pattern holds true regardless of race.

Rural areas will continue to lose population as the metropolitan areas and amenity areas continue to attract migrants. As a result, the depopulated areas may either be overemployed or underemployed, depending on whether consumers or producers leave. This rural loss, however, proceeds in stages. Rural farm types may move to the regional center and then onto a medium-sized metropolitan area. Thus, small urban places (between 10 and 50 thousand) may grow quite rapidly in those areas undergoing transition in the rural agricultural base. Secondly, much of the "rural" population is non-farm and growing in size. Goods and services supplied to meet their increasing needs will support growth in regional market towns.

Life Style, Activities, and Leisure Time Patterns

One of the most important variables one needs to investigate in the area of life style, activities, and leisure time patterns is the amount of discretionary time available. Sex, family responsibility level, and work status are all important determinants of this variable. In one study, for example, the fulltime working female with young children had only slightly more than one-third as much discretionary time (2.6 hours/day) as the part-time working male with no young children (8.2 hours/day) (19). Contrary to expectations, however, income differences do not seem to affect differences in discretionary time. Other studies support these findings between occupations and across different communities. Higher income people, however, do spend more of their discretionary time outside the dwelling unit than lower income people.

Although professionals are more work-oriented than non-professionals, professionals have a higher affinity for vacations and leisure activity, whereas trades-people, for example, seem to have enough leisure time and are less work-oriented (26, 54).

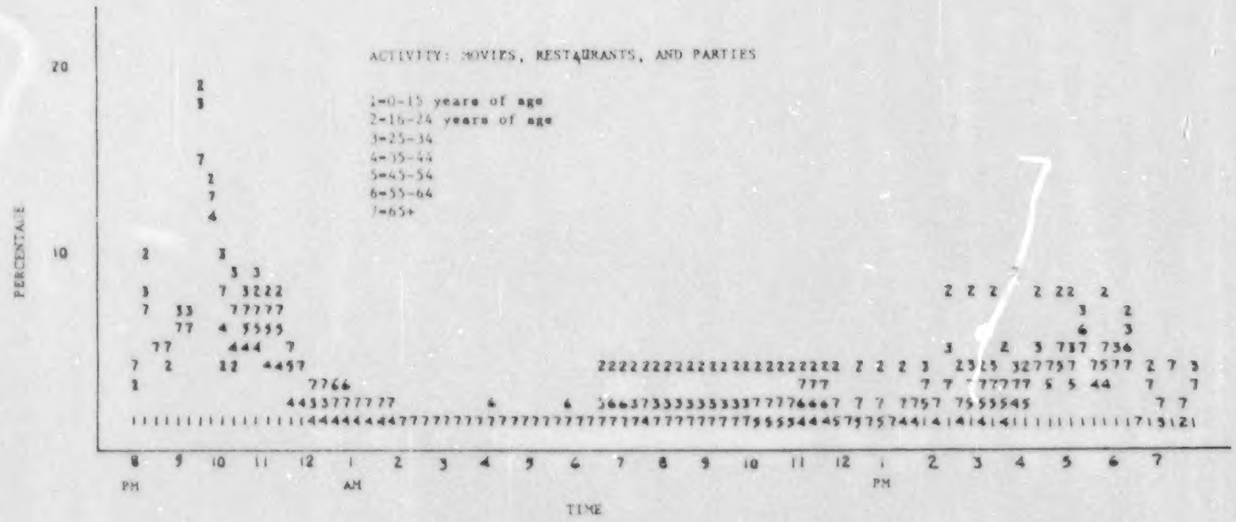
Younger people and single people are, in general, more leisure-oriented than older married types. At the other end of the age spectrum, however, retirees, particularly in retirement communities, develop more leisurely life styles (22). One study revealed some measure of detail on leisure time activities. Members of the sample population were called on the telephone and asked to recall their activities for the previous 24-hour period. For the activity grouping, "restaurants, parties, and movies," although no more than 8 percent of the population as a whole engaged in this activity at a given time period, up to 19 percent of the age cohort 16-24 and 18 percent of the age cohort 25-34 were engaged in this activity for a given period of time (See Figure 11) (10).

This same study reported much higher rates of the activity, "eating and drinking in residences," for upper and middle class professionals than for the rest of the population. For example, at one point, 72 percent of the upper class professionals and 48 percent of the upper middle class professionals were at home for supper, whereas only 26 percent of the population taken as a whole was at home for supper. These results must be interpreted carefully, due to small sample size. Also, the data reports temporal patterns: there may appear to be sharp differences in the frequency of an activity, but these differences hold only for selected times. Clearly, almost everybody eats supper, but not everyone eats at the same time, or for the same length of time, or at home. Apparently, however, many upper and upper middle class professionals do.

Certain trends in leisure time activity may be emerging. At

Figure 11

Activity Responses



Source: Bazan, LeDoux, and Reiff, "Study Population Activity Patterns," in The Wesley Town Games. Working paper prepared for The Center For The Study of Environmental Policy, The Pennsylvania State University, University Park, PA. (forthcoming, 1974).

present, about 1/4 of 1 percent of laborers are on a 4-day 40-hour work week. This level will probably continue to increase. But right now it is not a significant part of the pattern. Rather, the significant changes in leisure time are measured by more paid holidays and longer vacations, not in shorter work weeks (15, 26, 48, 53, 64).

Due to decreasing family sizes, women's worklife expectancy will continue to increase. This observation is reinforced by better pensions, social security, and greater longevity, as well as by changing family structure and role differentiation (35, 55).

Structure of the Food Services Sector

Introduction

We focus, in this second section, specifically on the food services sector. The food services sector is one aspect of the population system we have been investigating. In many respects, the food services sector lags behind the population sector. Thus, the trends we see in the population system as a whole appear later in the food services sector. We summarize a number of structural and institutional trends in this section.

Institutional Trends in the Food Services Sector

Decision-making and planning in the food services sector will be affected by laws and regulations relevant to the industry; by changes in technological forecasting; by new marketing techniques; and by changes in the food service delivery system. We outline some of these trends here.

Laws and regulations. The legal constraints or food service come from either the federal or the local level. The possible further regulation of franchising activities by the federal government could severely limit food service industry expansion. Fortunately for food services, many congressmen view franchising as a means of keeping small businessmen viable in a world of big business, even though the franchisers themselves are among the biggest firms in the sector. The evolving guidelines are that franchising restrictions are considered based on the allocation of financial risks between the franchisor and the franchisee. There has also been a strong effort to set up minority members in franchising operations; as a result, Small Business Administration loans have become increasingly available for franchisees (6, 25). (While these observations are dated, the pattern persists at the time of writing.)

The outlook seems equally favorable on the local level. Although there have been some minor exceptions, zoning decisions have firmly established fast food operations as restaurants; as such, they are entitled to all the opportunities open to restaurants. Noise, parking, congestion, and other similar ordinances have done little to impair restaurant locational freedom (70-79 incl.).

Food delivery systems. The systems approach is of great importance in the food service industry; within the industry, the fast food operations have used this mode to greatest advantage (4, 29). One observer, in examining the success of McDonald's, notes that they have extremely low failure rates and a high number of repeat customers[1]. He attributes this to entrepreneurial financing, wise site selection, and rapid delivery of a high quality product in a clean environment. In fact, the whole unit is designed to maximize product performance with great attention to details.

Technological forecasting. The systematic handling of information in industry for forecasting purposes is gaining, but its effect is still quite minor. New methods have been developed to the point of reasonable accuracy; it is their application, however, that lags (14). One model developed assesses the changing locational advantages of sites over time and could be relevant to the food service sector. New locations arise because of changing costs, volume, and destinations.

Marketing techniques. Rather than blindly increasing sales, many marketers are trying to shape demand to conform to long range objectives. This "de-marketing" may be general, selective, or ostensible (47). Marketing should regulate the shape and level of demand so that it conforms to the organization's current supply situation. In the food service sector, this approach could be crucial, given highly engineered service structures and tight inventory schedules.

Factors that will help shape the future of the food service industry include the development of distribution networks, more accurate site selection, the structure of agribusiness units that supply raw materials, and the internal structure of the food services sector itself.

Food distribution networks. Two trends are emerging in the distribution of goods. One involves the transformation of the distributor to a wide product line. (The ultimate case would be one distributor handling all the needs of one consumption unit.) A proliferation of services may accompany this movement, including menu consulting, merchandising assistance, recipe development, food costing, and computerized billing, ordering, and inventory recording (68).

Another trend involves cost-plus pricing. This practice could entail 7-day instead of 30-day billing. It would thus require the individual unit to keep a higher inventory and would also require of the individual unit more advanced planning (68).

On another scale, the innovations in communications and transportation have brought about the decline of the terminal market--for example, the Chicago stockyard (32,56). Thus, the decentralization of distribution into market areas is both more feasible and more probable. This also means that direct purchase form feeder to packer has become the predominant means of marketing in the meat industry. This elimination of an intermediate step could provide both higher profits to growers and lower costs to packers.

Agribusiness units. The continuing trend in agribusiness is towards more vertical integration of product acquisition and delivery (31). This has meant that control over decisions in agribusiness has been increasingly shifted to non-farm firms. One forecast explains that because of the concentration of technology, communication, and organization, these firms can use their control to extract the most from those who buy from it and sell to it.

Site selection. Although the site cannot, by itself, determine project viability, its accurate selection can optimize whatever profits can be made, and in some cases surmount other bad decisions. Thus, the continued development of site location technology is of real importance to the food service industry (3). The site must be selected in the context of market policy and in relation to the specific nature of the goods sold and the market population. Tools include indices of shopper effectiveness, customer survey techniques, and general observational methods.

Trends in the food service industry. The advantages of the franchised sector of the industry include centralized buying, centralized promotion, untapped market potential, better than average growth and survival rates, reduced opening costs, and continuous checks on unit operation. One Wall Street analyst also mentioned several weaknesses--accounting methods, possible antitrust action, inexperience of many entrants to the field, over saturation of market areas, and setback in franchising (37).

Standard and Poor's June, 1973, market analysis concluded that restaurant problems have been overstated (63). In reality, minimum wage legislation would affect restaurants only marginally. Gasoline rationing would have little effect as many companies depend on residents in the area to provide from 80 to 90 percent of revenues. The report concluded that total sales would expand 8 percent annually over the next ten years as it had over the past ten years. This growth prognosis is based on increasing numbers of people in the 20 to 34 age cohort, increased levels of disposable income, increasingly mobile people, longer vacations, shorter work weeks, changing life styles, larger promotional campaigns, and more women in the work force.

The top 100 companies dealing in fast food services increased their share of the sales from 29.5 percent in 1965 to 36.1 percent in 1972. Advantages in size include attracting top managerial talent, establishing internal commissaries, and being generally well known in market areas.

Current trends in the industry point to more complex operating systems, increased emphasis on company owned units, and the belief that market saturation is a long way off. These trends tend to reinforce the dominance of the majors, and they should continue to gain more of the market in the future.

Structural Trends in the Food Services Sector

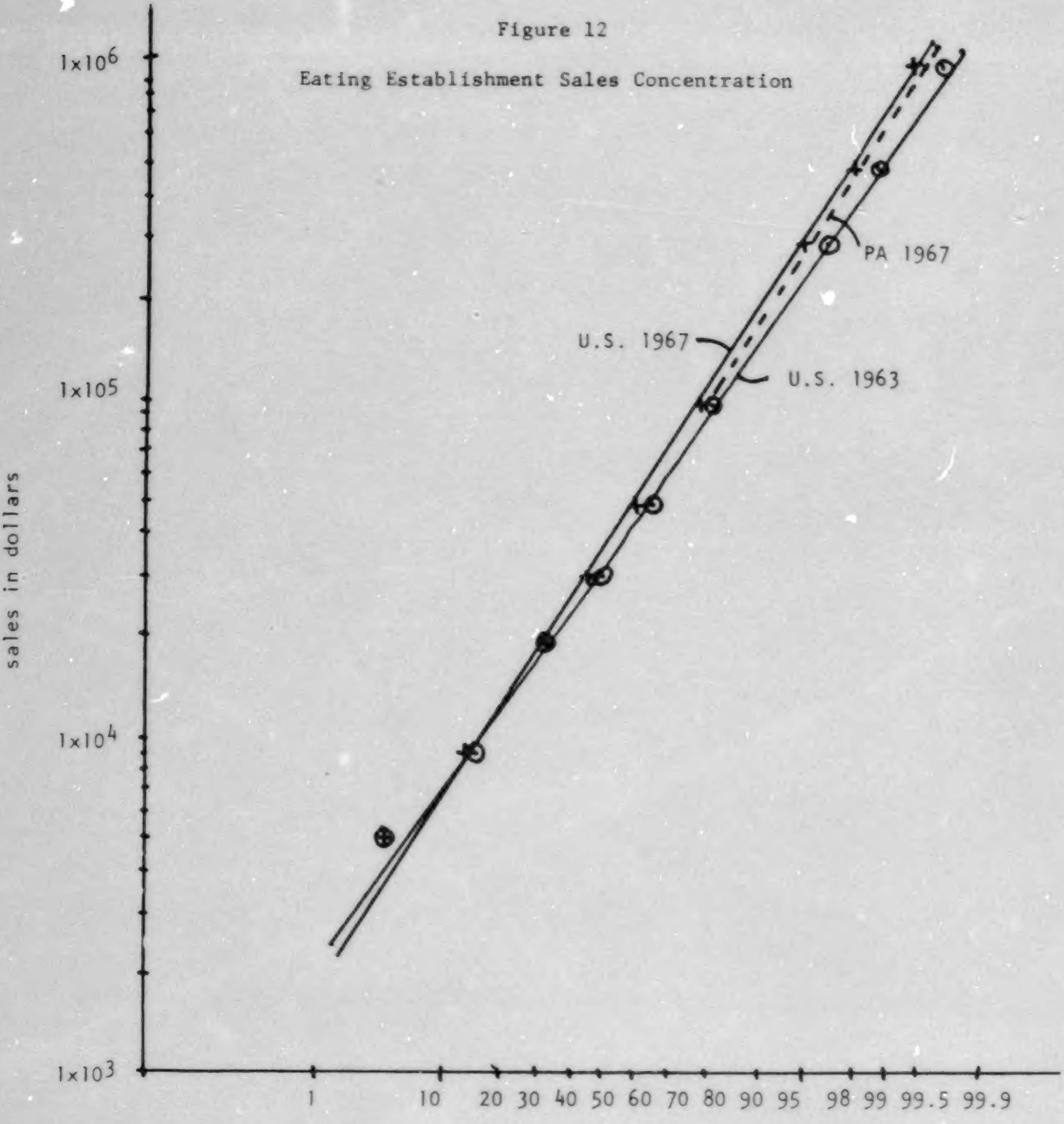
Before looking at spatial patterns in Pennsylvania specifically, we must first establish a picture of the structure of the eating sector at a national level. This approach allows us to delineate major trends and to establish a basis for comparing Pennsylvania with the rest of the country.

We make these comparisons graphically with the use of the lognormal distribution, a simple distribution often used where there is a degree of concentration in an economic sector of the market (8, 9, 59). Economic concentration in a sector is characterized by a faw estabishments having a large proportion of sales and a large proportion of establishments having a small proportion of sales.

From Figure 12 we see that eating places are characterized by a moderate degree of sales concentration, with the top 2 percent of establishments earning above $500,000 a year in sales. Of a total of 220, 236, these 4,480 establishments earn 22 percent of all the sales in that sector. The graph indicates a slight increase in concentration between the years 1963 and 1967. During this period, over 30,000 establishments in all size classes went into business. Primarily, however, growth was most rapid among establishments of the largest size class, which accounts for the increasing concentration in 1967. This could have been caused by large establishments entering the sector for the first time, or more likely, by growth in sales of establishments in smaller size classes which then migrate to larger size classes. Inflation may also have caused an apparent increase in concentration.

Figure 12

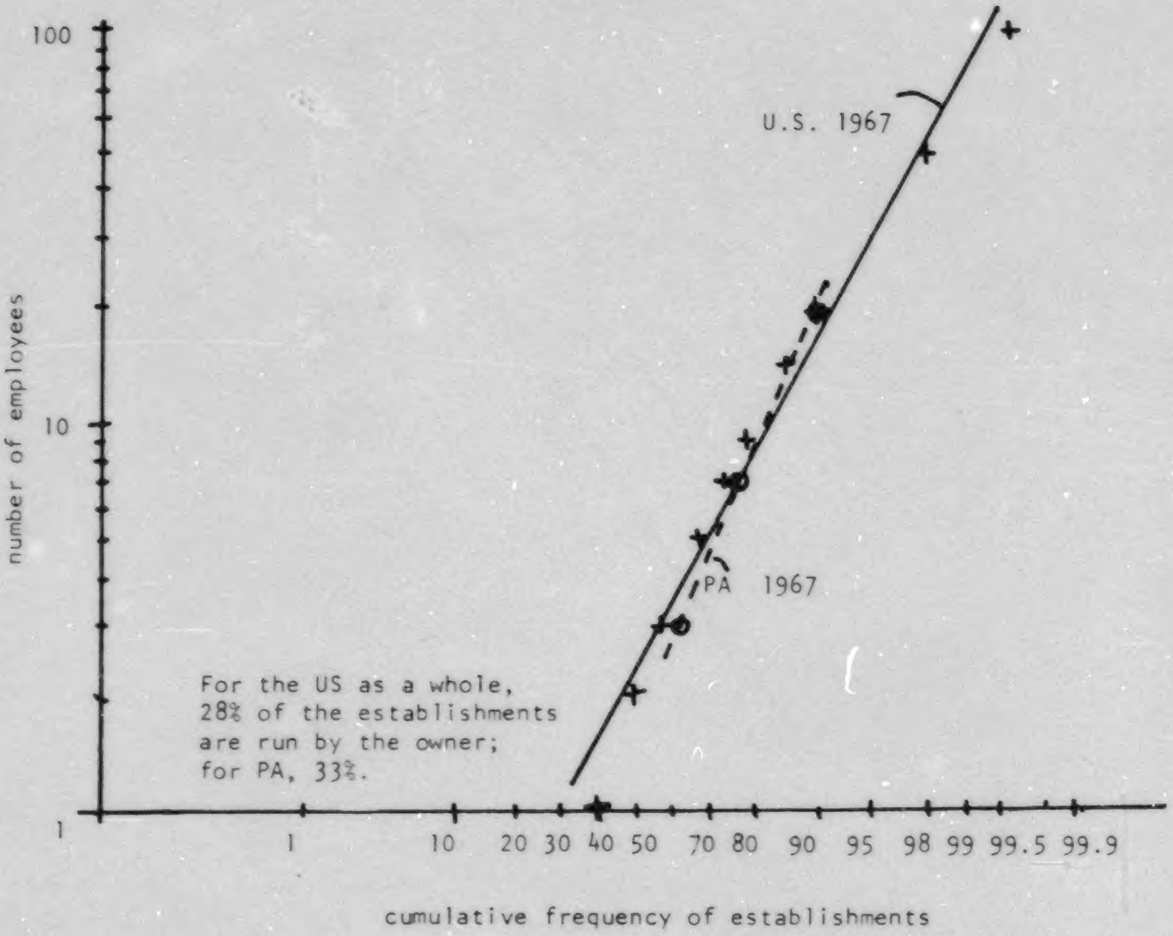
Eating Establishment Sales Concentration



Source: U.S. Census of Business, Retail Trade Subject Reports, Vol.1 Table 1 and Table 3.

Figure 13

Eating Establishment Employment Concentration

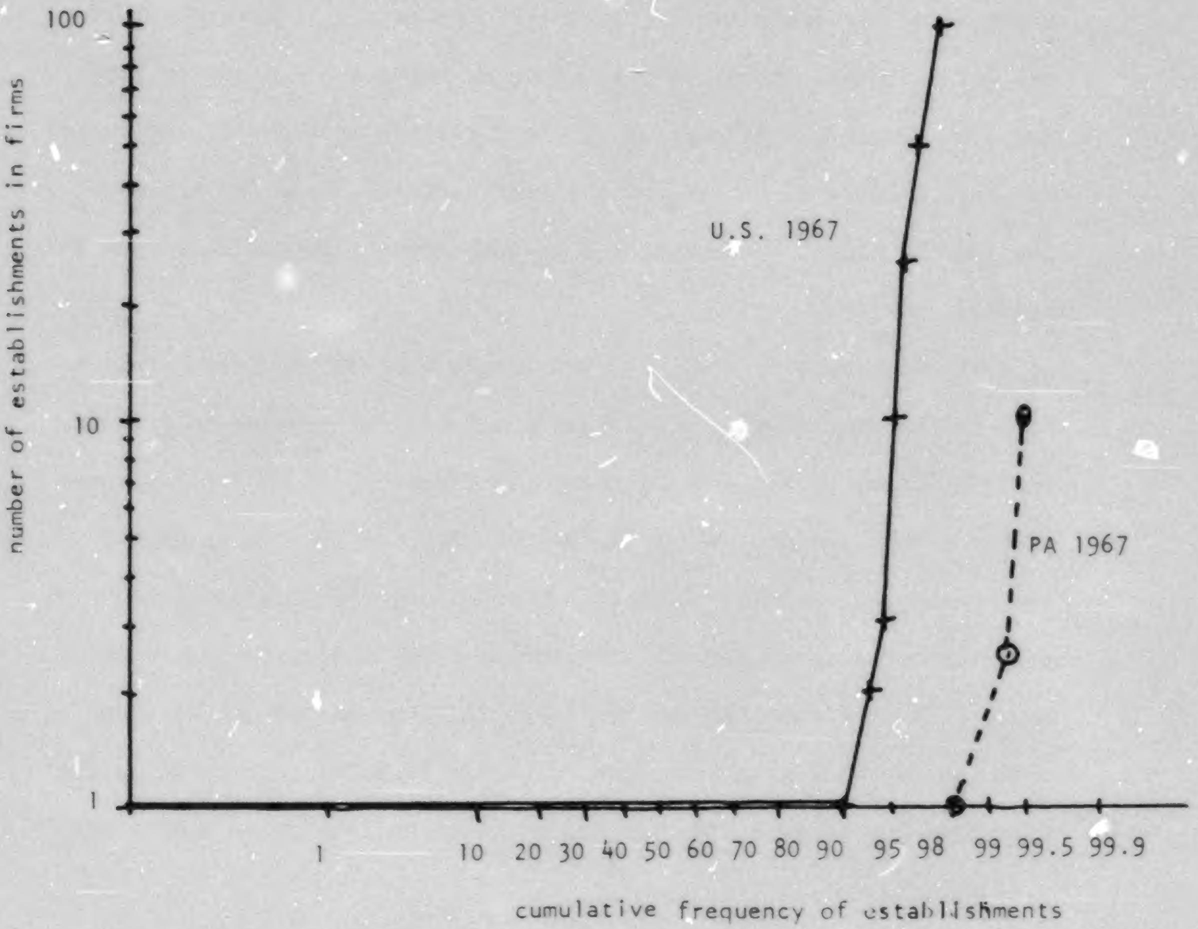


Source: U.S. Census of Business, Retail Trade Subject Reports, Vol. 1 Table 1 and 2.

Figure 14

Percentage of Multi-Unit Firms in

Pennsylvania and the U.S. (1967)



Source: U.S. Census of Business, Retail Trade Subject Reports, Vol. 1
Table 1 and 3.

The Pennsylvania data, sandwiched between the 1963 and 1967 data for the country as a whole, indicates that the structure for Pennsylvania is not far different from that of the country.

Similarly, from Figure 13, we can see that a similar pattern appears for the employment structure of the eating sector. Most of the eating places employ very few people, whereas a few employ large numbers. Twenty-eight percent of the establishments are run by their owners. Roughly 84 percent of all establishments have ten or fewer employees. Again, Pennsylvania does not depart substantially from the national picture.

Finally, most of the firms are single unit enterprises. This is true for 90 percent of the establishments for the country as a whole and 98 percent of the establishments in Pennsylvania. Only 5 percent of the establishments belong to firms having ten or more units for the country as a whole. Less than one-half of one percent of the establishments in Pennsylvania belong to firms having ten units or more. (These figures appear in Figure 14.) We can expect more and more food service establishments to belong to multi-unit firms as the fast food and other restaurant chains continue to grow in number and size (18, 23, 61, 69).

Structure and Trends of Population and Food Services for Pennsylvania

Introduction

Although the results for the country as a whole are insightful and suggestive, and would help investors and planners in the food services sector, because economic decisions take place in and have an effect on space, it would be more helpful to look at a given spatial area in great detail. This approach helps confirm the broader trends as well as develop specific policy guidelines. The authors investigated the State of Pennsylvania as an example of how the methodology is applied and as an illustration of the kinds of results one can expect.

Method

Data was obtained from U. S. Census Reports for population of urban places, number of firms in the eating and drinking sector by urban place, and sales in the eating and drinking sector by urban place. Land areas of urban places were also obtained. This data was collected for two different time periods to permit an observation of trends. Furthermore, the urban place data was divided into two categories, SMSA urban places and non-SMSA urban places, to permit a more careful examination of expected differences in urban places at different levels of the urban hierarchy and with different functions. These two categories are hereafter referred to as "urban" and "rural" places respectively.

The data tables portraying the values for the variables described above are given in the Appendix. Data was collected for all urban places in Pennsylvania and aggregated for easier analysis into the following 12 population size classes:

1. 1,000,000 and above,
2. 750,000 - 999,999,
3. 500,000 - 749,999,
4. 250,000 - 499,999,
5. 100,000 - 249,999,
6. 75,000 - 99,999,
7. 50,000 - 74,999,
8. 25,000 - 49,999,
9. 10,000 - 24,999,
10. 7,500 - 9,999
11. 5,000 - 7,499, and
12. 2,500 - 4,999.

A series of questions face decision-makers in the food service sector. These questions have to do with (1) the location of the population to be served; (2) the composition of the market population at a given location; (3) the kinds of economic activities engaged in by the market population; (4) the types of people involved in a given economic activity; (5) the location of such economic activities as food service establishments; and (6) the numbers, types, and sizes of food service establishments in a given urban place location.

One way to begin answering these questions is to look at locational concentrations of the activity eating and drinking relative to the population and then to make comparisons over time. One makes these comparisons by using the Lorenze curve (40). The Lorenze curve, as used in this study, simply portrays the extent of concentration of the chosen variable on land. If the line is straight (as the reference line drawn 45 degrees to the axes), it indicates that the variate in question, say population, is equally distributed over the land area. The more the line is curved relative to the straight line, the more concentrated the population is relative to the land area. Since population divided by land area represents density, this curve simply measures the extent of density variation. In Figure 15, for example, we see that 50 percent of the urban population lives on only 25 percent of the urban land area.

By looking at Figure 15, we see that the population was more concentrated in 1960 than it was in 1970. This supports the hypothesis that the population is becoming gradually more suburbanized in Pennsylvania. The gini coefficient is an index used to measure this degree of concentration. It is equal to the ratio of the area under the curve to the area of the triangle and varies from 0 to 1. Zero, of course, reflects no concentration and one represents high concentration.

Results

The results of our data analysis are plotted in Figures 15 through 20. The numbers along the graph segments indicate the urban place size class category associated with that line segment. In general, we would expect to find the size class categories with the largest urban places close to the origin, because their line segments have the

Figure 15

Population Concentration Urban Places (A)

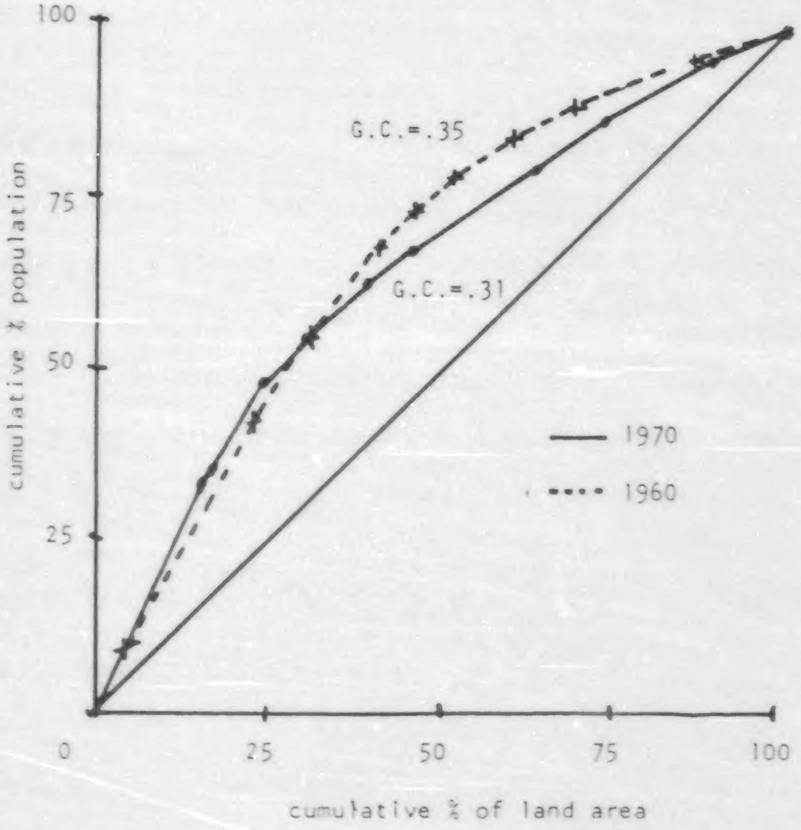


Figure 16

Population Concentration Rural Places (A)

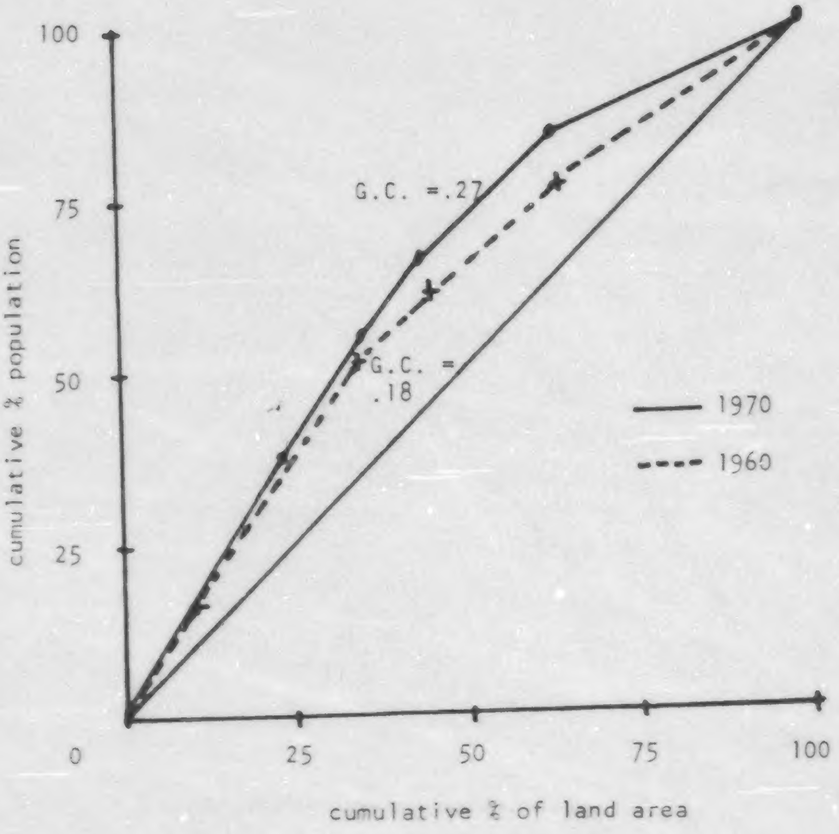


Figure 17

Population Concentration Urban Places (B)

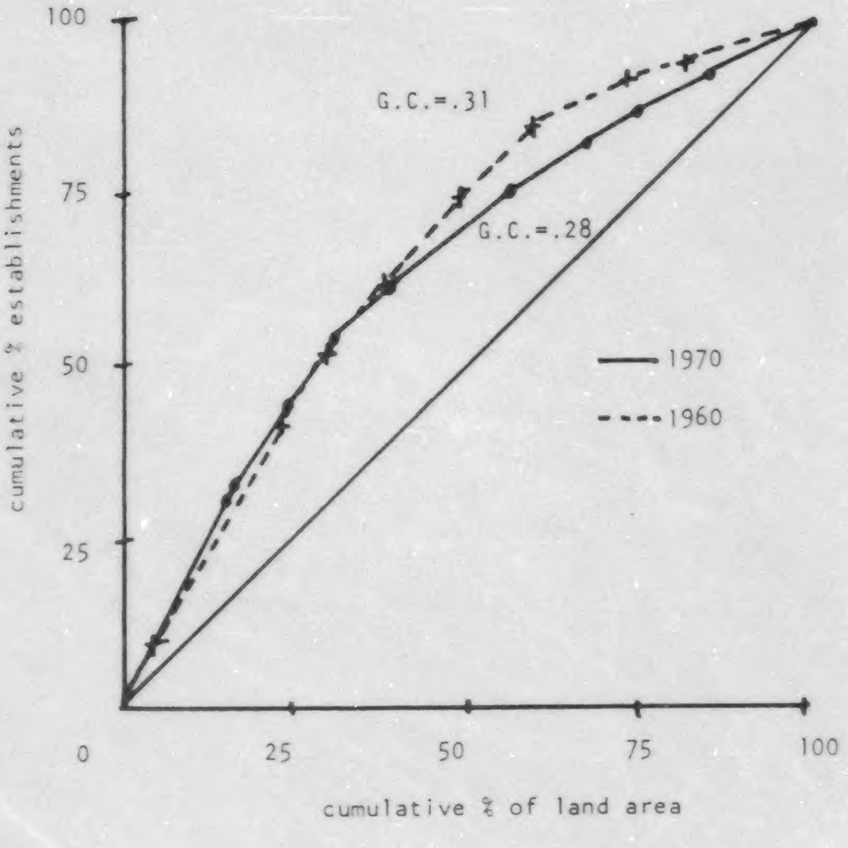


Figure 18

Population Concentration Urban Places (C)

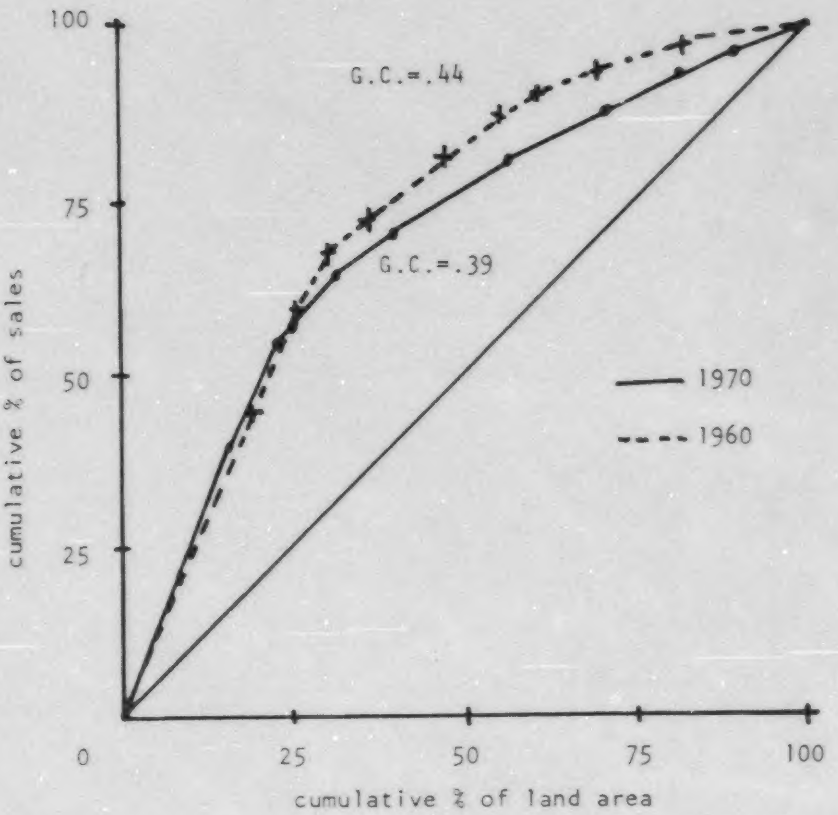


Figure 19

Population Concentration Rural Places (B)

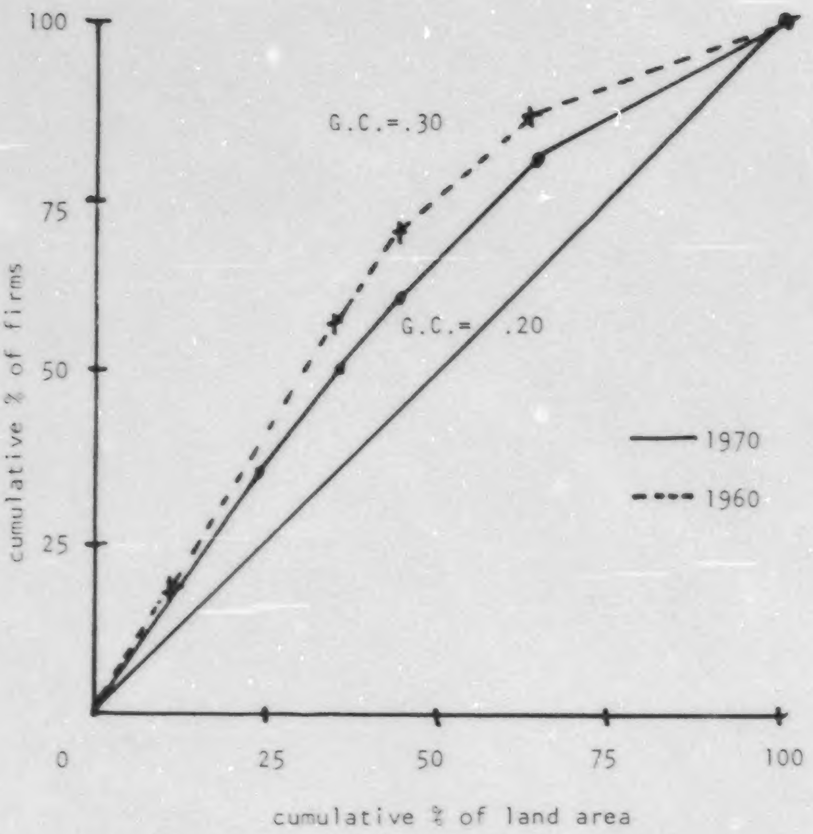
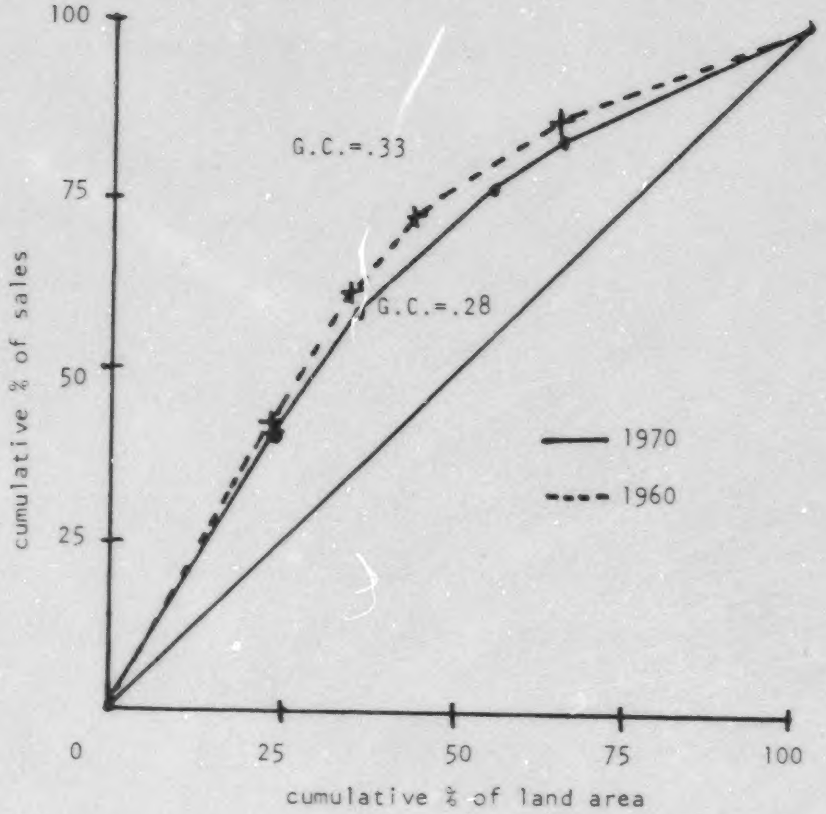


Figure 20

Population Concentration Rural Places (C)



steepest slopes, and therefore indicate the highest densities. As we would expect, our data in general shows higher densities in larger places, which confirms our hypothesis of urban systems structure.

From these figures we can make a number of interesting comparisons. For example, Figures 15 and 16 indicate that whereas urban places have become suburbanized between 1960 and 1970, the population in rural places has become more concentrated. This suggests a movement of people from small rural villages to larger regional places as a continuation of general rural-to-urban migration trends in past years in other parts of the country.

From Figures 17 and 18 we see that, for urban places, the concentration of establishments and sales has followed the concentration of population and has declined. Given decreasing total population in urban places, this means that many establishments are leaving the market. In general, the number of establishments are less concentrated than the population, whereas sales is more concentrated than the population, indicating that the average sales of establishments in denser areas is much higher on a per establishment basis than the sales of establishments in less dense areas. For the rural places, this last relationship is true only for 1970, indicating that perhaps the rural system has just recently come into conformance with the urban system.

Entry of new establishments has occurred in urban places, but only in the smaller urban places. This occurrence, as well as the establishment exit trend already mentioned, has contributed to the declining concentration of establishments and sales in urban places, in general.

The picture emerging in urban places, then, seems to be this: Total population is declining as the urban population is suburbanizing. Establishments sales in general have followed the population out of urban places. Whether food service establishments have become re-established in suburban areas cannot be concluded from this data.

Trends in rural places oppose the urban trends in certain aspects. The increasing concentration of population has not been followed by an increasing concentration of establishments or sales in rural places. Rather, the opposite has taken place, and the concentration of establishments and sales has declined, as shown in Figures 19 and 20. This decline appears to have been caused by the entry of new establishments in rural places of the two smallest size classes, despite an absolute decrease in the total population in these two size classes. One could hypothesize that the demand for these services has increased phenomenally, probably due to their having been undersupplied in the past. Also, a changing occupational structure in rural areas from farm to non-farm could account for changing incomes and tastes, and thus for changing demand.

Thus, then, is the picture that seems to be emerging in rural places: The total population in rural places has declined as people move from rural to urban places. At the same time, however, population shifts are occurring between different rural size classes. Although the smallest places (2,500-4,999) are declining absolutely in population, their demographic and occupational structure is changing so drastically that the demand for eating and drinking services is rising rapidly, calling forth new investment, new establishments, and high sales. On the other hand, population is shifting to the medium-sized rural places; however, two responses are occurring. Structural changes in some of these places (those in the population size class 5,000 - 7,499) are similar to those taking place in the smallest places (2,300 - 4,999). Thus, new establishments are entering the market. In the large places, however (those in population size classes 7,500 - 24,999), even though population is increasing, establishment entry is not keeping pace. Structural changes are probably not as profound. Although many older style restaurants are still in business, many are going out of business and are not being replaced rapidly enough by new units.

Scenarios for the Pennsylvania Food Service Sector

Introduction

At this point, we will summarize and draw upon our results in the previous section to construct a number of possible scenarios for the future of Pennsylvania food service. These scenarios are not meant to be exhaustive; they suggest a few alternative configurations. In this sense, however, they serve a heuristic purpose.

The Scenarios

Population movement. The current trend in Pennsylvania is for suburbanization in the metropolitan areas and the concentration of population in the non-urban centers of rural areas. If this process continues in its present form, food service establishments will continue to move from their central city locations to the suburbs. In rural areas, the continuance of the present trend would suggest rapid growth in certain areas until the market has been satiated and then a leveling off. It would also seem to mean that medium-sized rural places would probably remain stable (in an absoulte sense) and the number of establishments in central cities would continue to decline.

There are two separable elements of population movement in Pennsylvania. One is the urban-to-suburban movement of population and food service establishments. The second is the movement into smaller rural places from the dispersed rural areas. It may be profitable to treat each of these elements independently in drawing alternative constructs of the future.

Changes in the urban-suburban pattern. Three changes in the urban-suburban migration pattern would almost certainly affect Pennsylvania food services.

(1) The future location of food services could be altered by a change in the intra-urban migration patterns. A similar effect could also be achieved by a change in facilities use with the residential pattern being held constant. Although there seems to be little evidence that this is likely to include a movement back to the central city, it becomes a more realistic condition if the city is made more accessible and a safer place to visit.

(2) If solutions are found for the more serious the central city's problems, it could become an area of commercial and cultural activity again. It could provide a comparative advantage in time savings and variety of attractions which would also mean that food service locations would locate in the central city once more. The pattern of industrial and commercial locations in the suburban areas might also be ameliorated by these developments, but the change to a central city location could be adversely affected by the high cost of land there.

(3) A subset of the previous scenario would be a reversal of the residential patterns and movement of people back into the central city. This would result in an even more significant reversal of demand patterns for food service in urban areas. The probability of this occurrence depends on a more complete solution to the more serious central city problems than those suggested in scenario 2.

Changes in the rural pattern. In the rural places there are two prominent alternatives to the continuation of the present trend. One is a simple reversal of the trend toward smaller central places and a return to the scattered forms of the past. A second possibility is the continued movement of people from scattered rural areas and their concentration in rural places of a larger size class. Here are our two scenarios:

(1) The reversal of the present trend seems the least likely of future courses. It calls for the reversal of a long term trend and a return to a different life style and less community contact. If this were to occur, the market potential of the smallest rural places would decrease because of a diminished density. It also assumes that transportation factors are held constant, an unlikely contingency.

(2) A second possibility is that the present trend will continue but that the concentration will shift to areas of larger population within the rural context. This would seem to be a more likely alternative because it is a small deviation of the current trend and allows for increased community contact. Since most employment in this sector is non-farm, a shift in the location of employment sources could be instrumental in causing a movement to larger rural places.

All of the previous scenarios operate under the constraint of future transportation patterns. The rural places that rely on a great deal of commutation to supply employment for their residents are most sensitive to changes in transportation structures and costs. There also are impacts in the suburban-urban movement patterns, but these are more likely to be met with a multi-modal transportation system unless there is sufficient pull in the central city to make it an attractive place to live.

Disposable income and lifestyle. The income and lifestyle data indicates a trend toward more leisure time, an increase in women's worklife expectancy, and in general, a trend toward more of the budget being spent eating outside the home. In addition, the data indicates that much of the restaurant trade is generated by the young (ages 16 to 34) and by upper and middle class professionals.

For Pennsylvania, the number of restaurants, and the restaurant sales in general, are expected to increase. The trend towards more holidays and longer vacations may well lead to a greater need for food services to serve such existing vacation areas as the Poconos, the "Dutch" region, or the Laurel Mountains--or new ones to be developed. While all resorts are likely to be affected, the areas oriented toward the upper and middle class professionals and to youth, may expect the largest increase in numbers of establishments and sales.

For rural areas, the decreased concentration of establishments and sales paired with an increased concentration of population may well continue. If that population is predominately non-professional, then the trend can be in the number of establishments in food services and a decrease in sales may well parallel the suburbanization trend in urban areas. That is, the upper and middle classes are leaving the more concentrated areas for less concentrated areas. This trend suggests the projection of an increased number of food service establishments in medium-sized rural places and a continuing decrease in the number of establishments in larger rural places.

The trend for establishments and sales to follow population moving out of urban places can be expected to increase. But this trend is only partially explained by the general movement of population from central cities to suburbs. The socio-economic status of the movers (namely, upper and middle class) indicates that the demand for food services may increase in suburbia more than the population. For central cities, the reverse may well be true. That is, the demand for restaurants may well decrease as the proportion of non-professional residents increases. This trend may be further escalated by the attraction of non-professional rural people to urban central cities.

From a more general perspective, however, all of the trends toward decreasing numbers of establishments and amount of sales will be lessened by the trend toward more leisure time for all classes.

Structural trends. Existing government regulations do not limit franchising or location or food service establishments. Establishments seem able to move freely to follow the population. A franchised operation represents a more viable business venture than a private business venture. Thus, with the existing regulations, franchised operations should become even more prevalent in Pennsylvania. Advanced methods of site selection, distribution, and market area formation should allow establishments to be more sensitive to population demands and socio-economic trends.

As capital purchases are more easily financed by franchises, and as franchises continue to increase, the trend toward the application of the systems approach will increase. Automation will create demand for new types of employment, and may cause unemployment to increase.

In Pennsylvania, newer firms are locating in suburban and smaller rural areas, and many of the new establishments are likely to be franchised. This trend has a number of implications for employment. Old establishments from more concentrated areas employed more workers, many of whom were unskilled. Newer establishments may employ far fewer people. In fact, increased unskilled employment in food services can be projected in the more concentrated areas. The total employment in food services, as in many automating industries, may well decrease and become characterized by less skilled employees on the production line. Increased centralization of menu planning, distribution, and marketing will simply cause a shift in the location of skilled employment.

Methodological Issues and Areas for Further Research

A number of methodological problems may have introduced bias into our results or provided us with a picture different from the correct one. First, the basic unit of analysis was the urban place; this is the smallest unit for which data can be collected. This restriction meant that we could not, in the absence of further analysis of SMSA's, for example, corroborate our view of the suburbanization process. Second, the aggregation of urban places into size classes, while defensible on pragmatic grounds, does cause a mixing of places with different functions. Ideally, one would consider each place separately, but that would have entailed excruciating work. Third, there were a number of categories for which data was not available. As these data vacancies tended to be more frequent for smaller places, places in smaller size classes were systematically underrepresented. But the total impact, although unknown, was probably quite small.

A number of problems are inherent in the data itself and in the way it is collected by the census. It is only with difficulty that one can impose a spatial framework on census data. This practice leads to many assumptions about the nature of the phenomenon one is testing. The imposition of an urban-rural dichotomy was one such imposition. Clearly, many urban places located in SMSA's are quite small, and would probably qualify functionally as rural places. The opposite is also true. Therefore, to make statements about the "rural" or "urban" nature of the derived distribution is somewhat speculative. One might have come to similar conclusions based on a different categorization. Finally, it must be mentioned that whereas data for "eating places" was available only for larger agglomerations (SMSA's, the country as a whole, the state), only the breakdown, "eating and drinking" was available for urban place data.

Most of the difficulties in the approach taken here could be ameliorated by a more detailed look at a few typical SMSA's and a few firms in the food services sector. This would yield useful information about detailed decision-making processes. Further, more detailed work on disposable income needs to be done. Although we know what people eventually buy, we don't know how specific groups spend their money.

Finally, there is the normative question of planned change. We have described what has taken place and what will probably take place given no intervention by the social sector. What the social sector might do should merit a little more attention than what we accord it here. But for the present, we feel we have begun to lay out the basic informational background on which detailed policy questions can be formulated.

APPENDIX

Urban SMA Places, 1970

Size Class	Population[1]	Land Area (sq.mi.)[2]	# Firms[3]	$ Sales[4]	Employment[5]
1. 1,000,000-	1,948,609	128.5	4,420	316,183	22,294
2. 750,000-999,999	--	--	--	--	--
3. 500,000-749,999	520,117	55.1	1,403	115,234	6,875
4. 250,000-499,999	--	--	--	--	--
5. 100,000-249,000	342,322	62.7	900	52,310	4,155
6. 75,000-99,999	87,643	9.6	291	18,637	1,097
7. 50,000-74,999	426,859	57.7	1,311	68,022	4,908
8. 25,000-49,999	350,039	84.7	801	37,798	3,966
9. 10,000-24,999	623,908	135.8	1,823	81,067	6,829
10. 7,500-9,999	259,938	53.5	581	27,790	NA*
11. 5,000-7,499	394,768	118.3	1,031	56,410	NA*
12. 2,500-4,999	236,176	90.9	907	53,301	NA*
TOTAL	5,190,376	796.8	13,460	806.732	50,124

Sources of Data

1. Population--United States Department of Commerce, Bureau of the Census, General Population Characteristics: Volume 40, Table 16 (1970).

2. Land Area--Commonwealth of Pennsylvania Department of Commerce, Pennsylvania Industrial Census Series, entire volume (1972).

3. # Firms--United States Department of Commerce, Bureau of the Census, Retail Trade--Area Statistics, Volume 40, Table 3 (1967).

4. $ Sales--United States Department of Commerce, Bureau of the Census, Retail Trade--Area Statistics, Volume 40, Table 3 (1967).

5. Employment--United States Department of Commerce, Bureau of the Census, General Social and Economic Characteristics: Pennsylvania, Volume 40, Tables 76, 77, 87, 106, 107, 118 (1970).

*Data not available

Urban SMSA Places, 1960

	Size Class	Population[1]	Land Area[2] (sq.mi.)	# Firms[3]	$ Sales[4]	Employment[5]
1.	1,000,000-	2,002,512	128.5	5,099	267,130	26,469
2.	750,000-999,999	--	--	--	--	--
3.	500,000-749,999	604,332	55.1	1,561	90,441	6,967
4.	250,000-499,999	--	--	--	--	--
5.	100,000-249,999	358,230	62.7	1,745	37,740	3,471
6.	75,000-99,999	271,032	36.3	802	19,494	3,526
7.	50,000-74,999	544,140	38.3	1,450	50,880	4,359
8.	25,000-49,999	285,182	48.2	1,093	31,862	2,618
9.	10,000-24,499	785,767	90.0	1,833	57,159	5,530
10.	7,500-9,999	207,671	62.0	526	18,875	NA*
11.	5,000-7,499	376,098	136.1	1,058	26,854	NA*
12.	2,500-4,999	250,113	99.7	770	23,103	NA*
	TOTAL	5,675,028	756.9	15,937	623,538	52,959

Sources of Data

1. Population--United States Department of Commerce, Bureau of the Census, General Population Characteristics, Volume 40, Table 13 (1960).

2. Land Area--Commonwealth of Pennsylvania Department of Commerce, Pennsylvania Industrial Census Series, entire volume (1972).

3. # Firms--United States Department of Commerce, Bureau of the Census, Retail Trade Area Statistics, Volume 38, Table 102, (1958).

4. $ Sales--United States Department of Commerce, Bureau of the Census, Retail Trade Area Statistics, Volume 38, Table 102 (1958).

5. Employment--United States Department of Commerce, Bureau of the Census, General Social and Economic Characteristics: Pennsylvania, Volume 40, Table 75 (1960).

*Data not available

Rural Non-SMSA Places, 1960

	Size Class	Population[1]	Land Area[2] (sq.mi.)	# Firms[3]	$ Sales[4] ($1,000)	Employment[5]
1.	1,000,000-	--	--	--	--	--
2.	750,000-999,999	--	--	--	--	--
3.	500,000-749,999	--	--	--	--	--
4.	250,000-499,999	--	--	--	--	--
5.	100,000-249,999	--	--	--	--	--
6.	75,000-99,999	--	--	--	--	--
7.	50,000-74,999	--	--	--	--	--
8.	25,000-49,999	142,099	25.1	394	10,769	1,317
9.	10,000-24,999	280,783	56.2	891	24,319	3,089
10.	7,500-9,999	75,756	20.1	285	6,123	NA*
11.	5,000-7,499	126,576	45.5	375	8,874	NA*
12.	2,500-4,999	199,303	85.8	287	7,229	NA*
	TOTAL	824,517	232.7	2,232	57,224	4,406

Sources of Data

1. Population--United States Department of Commerce, Bureau of the Census, General Population Characteristics, Volume 40, Table 13 (1960).
2. Land Area--Commonwealth of Pennsylvania Department of Commerce, Pennsylvania Industrial Census Series, entire volume (1972).
3. # Firms--United States Department of Commerce, Bureau of the Census, Retail Trade Area Statistics, Volume 38, Table 102 (1958).
4. $ Sales--United States Department of Commerce, Bureau of the Census, Retail Trade Area Statistics, Volume 38, Table 102 (1958).
5. Employment--United States Department of Commerce, Bureau of the Census, General Social and Economic Characteristics: Pennsylvania, Volume 40, Table 75 (1960).

*Data not available

Rural Non-SMSA Places, 1970

	Size Class	Population[1]	Land Area[2] (sq.mi.)	# Firms[3]	$ Sales[4] (1,000)	Employment[5]
1.	1,000,000-	--	--	--	--	--
2.	750,000-999,999	--	--	--	--	--
3.	500,000-749,999	--	--	--	--	--
4.	250,000-499,999	--	--	--	--	--
5.	100,000-249,999	--	--	--	--	--
6.	75,000-99,999	--	--	--	--	--
7.	50,000-74,999	--	--	--	--	--
8.	25,000-49,999	138,857	25.1	370	18,435	1,676
9.	10,000-24,999	298,509	56.2	860	40,919	3,051
10.	7,500-9,999	88,511	20.1	248	7,518	NA*
11.	5,000-7,499	146,295	45.5	481	17,270	NA*
12.	2,500-4,999	126,517	85.8	496	17,467	NA*
	TOTAL	798,689	232.7	2,455	101,609	4,727

Sources of Data

1. Population--United States Department of Commerce, Bureau of the Census, General Population Characteristics: Volume 40, Table 16 (1970).

2. Land Area--Commonwealth of Pennsylvania Department of Commerce, Pennsylvania Industrial Census Series, entire volume (1972).

3. # Firms--United States Department of Commerce, Bureau of the Census, Retail Trade Area Statistics, Volume 40, Table 3 (1967).

4. $ Sales--United States Department of Commerce, Bureau of the Census, Retail Trade Area Statistics, Volume 40, Table 3 (1967).

5. Employment--United States Department of Commerce, Bureau of the Census, General Social and Economic Characteristics: Volume 40, Table 76, 77, 87, 106, 107, 118 (1970).

*Data not available

Planning Aspects Affecting the Future of Food Service:

A Bibliography

1. Anon. "A second look at the Levitt Doctrine." *Marketing* (May, 1970), pp. 30-31, 40.

2. Anon. "A year reviewed: Youth and food service in 1973." *Food Service Marketing* (December, 1973), pp. 18, 48, 50, 51.

3. Anon. "Finding the right site." *Marketing* (June, 1972), pp. 41-43.

4. Anon. "HARDEE'S: Total systems approach to fast service restaurants." *Food Service Marketing* (July, 1973), pp. 36, 38, 40, 60, 65.

5. Anon. "Special report: The new role of food distributors." *Volume Feeding Management* (March, 1970), pp. 35-36.

6. Anon. "Washington: Are controls in the works?" *Volume Feeding Management* (January, 1970), pp. 34-36.

7. D. A. Aaker. "Toward a normative model of promotional decision making." *Management Science*, 19(6) (February, 1973), pp. 593-603.

8. J. Aitchison and J. A. C. Brown. *The Lognormal Distribution*. (Cambridge: Cambridge University Press, 1966).

9. E. J. Bazan. *A Monte-Carlo Simulation of the Lognormality of a Central Place System of Disposal Sites*. Ph.D. Dissertation, Cornell University, Ithaca, New York, 1974.

10. E. J. Bazan; R. LeDoux and E. Reiff. "Study population activity patterns in *The Wesley Town Games*." Working paper prepared for The Center for the Study of Environmental Policy, The Pennsylvania State University, 1974 (forthcoming).

11. Brian J. L. Berry. "General features of urban commercial structure." In Bourne, *Internal Structure of the City*. (London: Oxford University Press, 1971), pp. 361-367.

12. J. M. Biggar. "Revolution in frozen food retailing." *Food Production/Management* (July, 1971), pp. 30-32.

13. D. W. Bishop. "Stability of the factor structure of leisure behavior: Analyses of four communities." *Journal of Leisure Research* (Summer, 1970), pp. 160-170.

14. A. Wade Blackman, Jr. "New venture planning: The role of technological forecasting." *Technological Forecasting and Social Change*, 5 (1973), pp. 25-49.

15. D. M. Blank. "The activities of leisure." *The Conference Board RECORD*, (July, 1971), pp. 55-57.

16. F. W. Boal and D. B. Johnson. "The functions of retail and service establishments on commercial ribbons." In Bourne, *Internal Structure of the City*. (London: Oxford University Press, 1971), pp. 368-379.

17. H. M. Boettinger. "Technology in the manager's future." *Harvard Business Review* (November-December, 1970), pp. 4, 5, 6, 8, 10, 12, 13, 14, 165.

18. A. J. Bradie, C. F. DeBiase; R. Reiss Jr.; A. L. Simon; and J. W. Tanner. "Restaurant industry: A round-table discussion." *The Wall Street Transcript*, XLII (7) (1973), pp. 5-19.

19. R. K. Brail and F. S. Chapin, Jr. "Activity Patterns of Urban Residents." *Environment and Behavior*, 5 (June, 1972), pp. 163-190.

20. G. Breckenfeld. "'Downtown' has fled to the suburbs." *Fortune* (October, 1972), pp. 80, 82, 83, 85, 87.

21. L. A. Brown and J. Holmes. "Intra-urban migrant lifelines: A spatial view." *Demography*, 8(1) (February, 1971), pp. 103-122.

22. G. Bultena and V. Wood. "Leisure orientation and recreational activities of retirement community residents." *Journal of Leisure Research*, 2(1) (Winter, 1970), pp. 3-15.

23. M. B. Burritt and J. E. Markham. "The food service industry: Where are we headed? Hospitality (July, 1973), pp. R35-R38.

24. P. T. Conover. "The alternate society: Its sources and its future." Technological Forecasting and Social Change, 5 (1973), pp. 295-304.

25. Joseph S. Coyle. "Wall Street: Part Bull, Part Bear, All Eyes." Volume Feeding Management (January, 1970), pp. 31-33.

26. D. A. Cunningham; H. J. Montoye; H. L. Metzner and J. B. Keller. "Active leisure activities as related to occupation." Journal of Leisure Research, 2(2) (Spring, 1970), pp. 104-111.

27. A. Downs. "Alternative forms of future urban growth in the United States." Journal of the American Institute of Planners (January, 1970), pp. 3-11.

28. A. Eisenpreis. "The goods for leisure and recreation." The Conference Board RECORD (July, 1971), pp. 58-61.

29. E. Evans. "A systems summation." Food Service Marketing (December, 1973), pp. 12-13.

30. R. Farley. "The changing distribution of Negroes with metropolitan areas: The emergence of Black suburbs." American Journal of Sociology, 75 (1970), pp. 512-529.

31. P. L. Farris. "What's happening in moving food from farm to consumer?" American Cooperation (1971), pp. 216-223.

32. Paul M. Fuller. "Replacing a Giant." Agricultural Marketing (February, 1971), pp. 6-7.

33. A. M. Guest. "Urban growth and population densities." Demography, 10(1), (February, 1973), pp. 53-69.

34. P. E. Hart and S. J. Prais. "The analysis of business concentration." Journal of the Royal Statistical Society, Pt. 2, 119, (1956 A), pp. 150-191.

35. E. M. Havens. "Women, work and wedlock: A note on female marital patterns in the United States." American Journal of Sociology, 78 (1972), pp. 213-219.

36. R. K. Hawkes. "Spatial patterning of urban population characteristics." American Journal of Sociology, 78(5) (1972), pp. 1216-1235.

37. Hayden Stone, Inc. The Specialty Restaurant Industry.

38. B. Imel and P. Helmberger. "Estimation of structure-profit relationships with application to the food processing sector." The American Economic Review (1971), pp. 614-627.

39. W. Isard. Location and Space Economy (MIT Press: Cambridge, 1956).

40. W. Isard. Methods of Regional Science. (Cambridge: Massachusetts Institute of Technology Press, 1960).

41. E. Jantsch. "Forecasting and systems approach: A frame of reference." Management Science, 19(12) (August, 1973), pp. 1355-1367.

42. A. Kirschenbaum. "City-suburban destination choices among migrants to metropolitan areas." Demography, 9(2) (May, 1972), pp. 321-335.

43. J. D. Kasarda. "The impact of suburban population growth on central city service functions." American Journal of Sociology, 77(6) (1972), pp. 1111-1124.

44. R. Kass. "A functional classification of metropolitan communities." Demography, 10(3) (August, 1973), pp. 427-445.

45. T. B. Knopp. "Environmental determinants of recreation behavior." Journal of Leisure Research, 4 (Spring, 1972), pp. 129-138.

46. P. Korcelli. "A wave-like model of metropolitan spatial growth." Papers of the Regional Science Association, Vol. XXIV (1970), pp. 127-138.

47. P. Kotler and S. J. Levy. "Demarketing, yes, demarketing." Harvard Business Review (November-December, 1971), pp. 74-80.

48. M. Leontiades. "The concept of leisure." The Conference Board RECORD, (June, 1973), pp. 25-28.

49. R. C. Martin. "Spatial distribution of population: Cities and suburbs." Journal of Regional Science, 13(2) (1973), pp. 269-279.

50. M. Mead. "The changing significance of food." American Scientist, 58, (March-April, 1970), pp. 176-181.

51. Peter A. Morrison. Population Movements and the Shape of Urban Growth: Implications for Public Policy (Rand: Santa Monica, California, 1972).

52. E. M. Mrak. "Changing patterns in the food industry." Food Production Management(February, 1973), pp. 8, 10, 12.

53. F. P. Noe. "Autonomous spheres of leisure activity for the industrial executive and blue collarite." Journal of Leisure Research (August, 1971), pp. 220-249.

54. J. Neulinger and M. Breit. "Attitude dimensions of leisure: A replication study." Journal of Leisure Research, 3(2) (1971), pp. 108-115.

55. V. K. Oppenheimer. "Demographic influence on female employment and the status of women." American Journal of Sociology, 78 (1972), pp. 184-199.

56. Roy H. Rockenbach. "Tradition Bows to a Changing World." Agricultural Marketing (February, 1971), pp. 4-5.

57. J. K. Shank; E. G. Niblock and W. T. Sandalls, Jr. "Balance 'creativity' and 'practicality' in formal planning." Harvard Business Review, (January-February, 1973), pp. 87-95.

58. H. A. Simon. "On a class of skew distribution functions." in Models of Man (John Wiley & Sons: New York, 1957), pp. 145-164.

59. H. A. Simon and C. P. Bonini. 'The size distribution of business firms." American Economic Review, 48 (September, 1958), pp. 607-617.

60. L. Smith. "Space for the CBD's functions." In Bourne, Internal Structure of the City (London: Oxford University Press, 1971), pp. 352-360.

61. E. J. Spar. "Fast food's sixth annual restaurant growth index--1973, Part II." Fast Food (September, 1973), pp. 125-152.

62. A. Speare, Jr. "Home ownership, life cycle stage, and residential mobility." Demography, 7(4) (November, 1970), pp. 449-458.

63. Standard & Poor's Industry Surveys "Retailing--Food." (October, 1973), pp. R157-R190.

64. I. Tallman and R. Morgner. "Life-style differences among urban and suburban blue-collar families." *Social Forces*, 51 (December, 1972), pp. 334-349.

65. P. H. Thurston. "Make TS serve corporate planning." *Harvard Business Review* (September-October, 1971), pp. 98-102.

66. J. Tucker and S. T. Friedman. "Population density and group size." *American Journal of Sociology*, 77(4) (1972), pp. 742-749.

67. R. F. Vancil. "The accuracy of long-range planning." *Harvard Business Review* (September-October, 1970), pp. 98-101.

68. Maxine Weisgrau. Distribution, Are You Part of the Solution or Part of the Problem." *Fast Food* (April, 1971), pp. 67-74.

69. G. Yetter. "Restaurant growth index--1973; Part I." *Fast Food* (September, 1973), pp. 77-92.

Zoning Cases

70. *Burger King of St. Louis, Inc*. *v*. *Weisz*, St. Louis Court of Appeals, Decided July 15, 1969, 444 S.W. 2d 517 (22 ZD3 Missouri)

71. *Wisner* *v*. *Board of Zoning Appeals for Frederick City*, Court of Appeals of Maryland, Decided May 8, 1970, 265 A 2d 183 (22ZD 359 Maryland)

72. *Vitolo* *v*. *Chave*, Supreme Court, Special Term, Nassaw County, Part I (trial court), Decided September 4, 1970, 314 N.Y.S. 2d 51 (23 ZD 82 New York)

73. *Western Income Properties, Inc*. *v*. *City and County of Denver*, Supreme Court of Colorado, En Banc (highest court), Decided May 17, 1971, 485 2d 120 (23 ZD 441 Colorado)

74. *O'Hagen* *v*. *Board of Zoning Adjustment*, Court of Appeal of California, First District, Decided August 9, 1971, 96 Cal. Rptr. 484 (23 ZD 577 California)

75. *Burger King Corp*. *v*. *City of Detroit*, Court of Appeals of Michigan, Decided May 11, 1971, 189 N.W. 2d 797 (23ZD 599 Michigan)

76. City of Burlington v. Joy Lee Inc., Supreme Court of Vermont, Chittenden, Decided April 4, 1972, 290 A 2d 23 (24 ZD 358 Vermont)

77. Twin City Red Barn, Inc. v. City of St. Paul, Supreme Court of Minnesota, Decided November 19, 1971, 192 N.W. 2d 189 (24 ZD 128 Minnesota)

78. Gino's of Maryland, Inc. v. City of Baltimore, Court of Appeals of Maryland, July 18, 1968, 244 a .2d 218 (21 ZD 17 Maryland)

79. Ederer v. Board of Zoning Appeals, Court of Common Pleas of Ohio, May 2, 1969, 248 N.E. 2d 234 (21 ZD 253 Ohio)

VI

ECONOMIC TRENDS INFLUENCING THE FUTURE OF THE FOOD SERVICE INDUSTRY

by

James D. Smith, Ph.D.,

Mark C. Schechter,

Russell J. Profozich,

and

James Wible

ECONOMIC TRENDS INFLUENCING THE FUTURE OF THE FOOD SERVICE INDUSTRY

Introduction: The Demand for Food

American consumers spent less proportionally on food in 1965 than any other nation. Twenty percent of U. S. consumption expenditures went for food in that year in contrast to the nation with the highest proportion for food, Ghana with 60 percent. In fact, the American proportion fell from 23 percent to 20 percent between 1955 and 1965. The marked difference of U. S. food consumption patterns from much of the remainder of the world raises questions concerning the nature of the demand for food in the United States.

The secular trend of food consumption expenditures is upward. This means that the demand for food is increasing. Total food consumption has increased monotonically since 1950, and 1965 total food consumption was about 35 percent above the 1950 level. On a per capita basis, food consumption expenditures also increased. In fact, per capita food expenditures have increased since the Great Depression. But even though food consumption has increased, per capita food intake in pounds and calories has decreased.

Changes in the demand for food are traditionally associated by economists with changes in disposable income, population growth, consumer preferences, and the price of substitutes.

Income

Americans' personal income has been rising over the past several decades: Total disposable income rose from $83 million in 1929 to $404 in 1963; and aggregate consumer expenditures for food have risen from $18 million to $72 million over the same time period. However, the proportion income spent for food dropped from 23 percent to about 19 percent. On a per capita basis, similar trends can be observed. Per capita food consumption since 1950 has increased as has income, but food expenditures as a percentage of income have declined.

Population

The population of the United States has, of course, increased, and that increase is positively correlated with total food expenditures. But population has not risen as fast as income, which has allowed personal income to rise. The effect of both rising incomes and rising population is to increase total food consumption. However, on both the aggregate and personal level, food expenditures as a proportion of income have declined.

Consumer Preferences

Consumer preferences have shifted toward the more highly prepared foods. This shift is reflected in the fact that the value of the farm share of total food expenditures has declined from 42 percent in 1929 to 32 percent in 1963. Consumers increasingly chose more highly processed foods and more food services. Thus the relative share of marketing has increased: The marketing share has increased as a proportion of total food expenditures, that is, but the total marketing bill has decreased as a proportion of disposable income since total food expenditures are a declining proportion of income. Since consumers are not physically consuming more food, higher food expenditures reflect the greater service component of food expenditures relative to the past.

The Price of Substitutes

The commodity composition of consumer preference has also changed. Although there are no substitutes for food as a commodity group, different foods act as substitutes for other foods. Consumer preferences have changed since early in this century. The demand for meats, dairy products, eggs, and fruits and vegetables has increased. Potatoes and cereal products exhibit diminished demand. More recent trends in commodity food consumption show that since 1950, commodity preferences appear to be negatively correlated with price movements.

The effect of rising income and population has been to increase the total demand for food. The effect of changes in consumer preferences has been influential in determining the magnitude and direction of demand with respect to various components of the food sector. And the effect of price changes is to influence consumer preferences through cost considerations.

Food Expenditures as a Proportion of Family Income

By Income Class and Family Size

Total Food Consumption

The average urban American family spent almost 22 percent of its income for food consumption in 1961. However, the percentage of income spent on food varies with income and family size. For example, the ratio of food consumption expenditures to after tax incomes of all urban families ranges from a high of 49 percent for families with incomes under $1000 to 13 percent for families with incomes of $15,000 and over. And the food-income ratio increases from 21 percent for single consumers to 27 percent for families with six or more persons.

Family income and family size are positively correlated. Family income and family size have opposite effects on the proportion of income spent on food. Unless their effects are measured independent of each other, their influences will be understated. Table I-C gives the independent effects of income and family size on food expenditures. For a family of three, the effect of income is seen in row 5. Although the average three-person family spent 21 percent of its income on food, the proportion varies from a high of 44 percent for those with incomes under $1000, to 11 percent for those with incomes of $15,000 and over.

The average family with an income between $6000 and $7500 spent 22 percent of its after-tax income on food. But one-person families in this income class spent only 16 percent, while families of six or more spent 28 percent of their after-tax income for food.

Food expenditures can obviously be divided into food consumption at home and away-from-home food consumption. On the average, 17 percent of after-tax income was spent for food consumed at home and 5 percent was spent on food consumed away from home.

Home Food Consumption

Home food expenditures vary from a high of 47 percent for a family of six or more with an income between $1000 and $2000 to a low of 7 percent for a family of two with an income over $15,000. The proportion of income spent for food at home declines as income increases, but moves in the opposite direction as family size increases. The similarity of total food expenditures and food at home expenditures results because food at home dominates total food expenditure.

Away-From-Home Food Consumption

Away-from-home food expenditures vary from a low of 2 percent for families of six or more with incomes between $1000 and $2000, to a high of 5 percent for families with incomes between $10,000 and $15,000. The most striking fact, however, is that the proportion of income spent for food away from home is relatively constant with respect to income and family size. For families of three, two widely separated income groups spent 5 percent of income for away-from-home food. They were families of three with incomes between $1000 and $2000; and $10,000 and $15,000. For families with incomes between $6000 and $7500, families of two and families of six or more each spent 4 percent on away-from-home food.

Interpretation

There are three factors that influence the share of income spent for food: biological influences, economies of scale, and alternative sources of satisfaction.

Biological influences. Urgency of hunger explains why at low income levels nearly all of a person's income goes for sustenance. In fact, at incomes below $1000, food expenditures tend to exceed income. To some extent this reflects a temporary situation in which a family's income drops for the year due to a business loss, but it also reflects the chronic plight of the poor. This same influence explains why those with low incomes spend more of their food budget for food at home than for food away from home. Families with incomes under $1000 spent 17 percent of their food budget on away-from-home food in the year 1960-61; those with incomes over $15,000 spent 32 percent. Higher incomes imply the capacity to satisfy the hunger urge. Consequently, food expenditures as a share of income decline in part due simply to the ability to satisfy hunger.

Economies of scale. Larger families require more food, but economies of scale are significant in offsetting the effect of more persons at the household level. Without being concerned with cost and technical advantages of preparing food for several rather than one or two, the data shows that the proportion of income spent for food did not increase as fast as would be expected on a per person basis. For almost all income classes, the proportion of income spent for food approximately doubled from the single consumer to families of 6 or more. Thus per capita income spent for food declined as family size increased, though

TABLE I

TOTAL FOOD CONSUMPTION EXPENDITURES AS A PERCENTAGE OF AFTER TAX INCOME 1960-61

Family Size	All Income Groups	Under $1000	$1000 1999	$2000 2999	$3000 3999	$4000 4999	$5000 5999	$6000 7499	$7500 9999	$10,000 14,999	$15,000 & over
	After Tax Income										
A. MEAN FOOD EXPENDITURES											
1. All urban families	$1311	$ 365	$ 528	$ 758	$ 962	$1139	$1310	$1508	$1809	$2166	$2820
2. Single consumer	619	320	450	608	716	818	822	1053	1089	1059	3572
3. 2 or more	1451	611	627	833	1036	1195	1344	1531	1825	2186	2809
4. 2	1090	509	618	756	919	1021	1123	1258	1453	1764	2489
5. 3	1440	423	627	815	1053	1189	1308	1456	1763	2042	2525
6. 4	1648	-	625	1005	1161	1292	1437	1627	1860	2250	2757
7. 5	1822	1362	649	1037	1279	1421	1501	1766	2092	2359	3345
8. 6 or more	1938	703	855	1220	1316	1503	1748	1887	2240	2670	3359
B. AFTER TAX MEAN INCOME BY INCOME GROUP AND FAMILY SIZE											
1. All urban families	$5988	$ 738	$1578	$2557	$3563	$4637	$5582	$6781	$8621	$11,822	$22,270
2. Single consumer	2926	716	1463	2480	3466	4413	5413	6669	8375	11,938	22,530
3. 2 or more	6509	394	1575	2522	3531	4517	5501	6712	8578	11,722	21,879
4. 2	5392	480	1570	2487	3528	4495	5489	6701	8500	11,712	22,248
5. 3	6818	962	1618	2579	3552	4519	5480	6731	8665	11,776	21,978
6. 4	7339	-	1602	2559	3549	4540	5521	6713	8597	11,892	22,888
7. 5	7478	-984	1404	2578	3508	4562	5499	6721	8551	11,573	21,747
8. 6 or more	7053	843	1735	2635	3484	4505	5537	6681	8544	11,503	18,898
C. MEAN FOOD EXPENDITURE/MEAN INCOME RATIO IN PERCENT											
1. All urban families	21.9	49.5	33.5	29.6	27.0	24.6	23.4	22.2	21.0	18.3	12.7
2. Single consumer	21.2	44.9	30.8	24.5	20.7	18.5	15.1	15.8	13.0	8.9	15.9
3. 2 or more	22.3	155.1	39.8	33.0	29.3	26.5	24.4	22.8	21.3	18.7	12.8
4. 2	20.2	106.0	39.4	30.4	26.0	22.7	20.4	18.8	17.1	15.1	11.2
5. 3	21.1	44.0	38.8	31.6	29.7	26.3	23.8	21.6	20.4	17.3	11.5
6. 4	22.5	-	39.0	39.3	32.7	28.3	26.0	24.2	21.6	18.9	12.1
7. 5	24.4	-138.4	46.2	40.2	36.5	31.2	27.3	26.3	24.5	20.4	15.4
8. 6 or more	27.5	83.4	49.3	46.3	37.8	33.4	31.5	28.2	26.2	23.2	17.8

Source: See Table IV

total food expenditures as a proportion of income increased. Large families take advantage of economies of scale by eating away from home less. Overall, smaller families tend to eat out more than larger families.

Alternate sources of satisfaction. Saturation of the desire for more food also explains why the share of income spent for food declines as income rises. Once one is above the level where hunger is satisfied, additional food consumption provides a smaller increment to total satisfaction. Total satisfaction grows by smaller and smaller amounts as more food is consumed. The economist calls this phenomenon "diminishing marginal utility." Total satisfaction may be increased at a faster rate by shifting from food to non-food commodities as income rises. This implies that the food share of income will decline.

Away-from-home food consumption suggest the influences of satiation as they become a larger proportion of total food expenditures. This explains why the away-from-home food share has a downward bliss at high income levels. The relative stability of away-from-home food expeditures is due to two facts: (1) The quantity of food consumed per person is relatively stable, and (2) away-from-home food consumption serves as an alternative source of satisfaction to eating at home.

The preceeding two sections have presented the nature and determinant of the demand for food. The emphasis will now shift to the food supply itself. Supply is the process by which the final consumer demands are met. Ultimately, the supply process may provide the basis for projections from which future labor requirements can be estimated.

The Food Supply System of the United States

Introduction

The assignment of dollar values to the individual stages in the formulation of a food supply, allows one to determine the effect of consumer demand for food products on the value of supply in past periods. With this supply response information, one can project supply values based on estimates of the future consumer demand for food products. By assigning labor's contribution to the dollar value in each successive stage of the supply flow in past periods, it is possible to project the labor participation requirements for the fulfillment of projected future food product supply needs. This section is confined to an examination of supply values, and their corresponding labor contributions for the period 1965 and 1969.

Flow of Food Products

The "from-to" flow of food begins at farms and fisheries and moves through differing levels of transformation (alterative production); and distribution (commodity markets, distributors and middlemen, manufacturers, and salesmen); through consumer outlets (retail food stores, public food service establishments, liquor stores, institutional food services, state and federal institutions) finally to the consumer. The flow of food may be characterized as a movement of dollar values. It is depicted in Table I.

As food flows from farms and fisheries toward its ultimate consumption, various things are done to it that require the expenditure of economic resources (land, labor, and capital.) The resources spent change the character of the food: packing, canning, preserving, cooking, and transportation from one part of the country to another. The economist thinks of these resource expenditures as adding to the value of the food. Thus he speaks of "value added" in various parts of the economic system. Value added can be measured in dollars or in units of resources.

Labor in the Supply Process

The retail value of food and beverage consumption for a given year is the sum of the values added at each stage of the flow. Of particular concern to our study is the value of labor. By disaggregating the total value added, we can examine labor's contribution at each stage of the flow. Our examination here is restricted to the contribution of nonsupervisory and production employees. We will look at total hours, aggregate remuneration, and average hourly wages. These statistics provide an overview of the quantitative and qualitative labor inputs at various stages of the flow. (They appear in Tables II and III.)

Consumer Outlets

The supply stage, designated "consumer outlets," (drawn from Tables I and II) is the major transfer point of food from industry to the consumer. Despite the overlap of "heat and serve" food products available through retail food stores and the "take out" dimension of public food service establishments, there exist some fundamental differences between the two primary types of consumer outlets. Retail food store purchases generally require additional preparation, while public food service establishments (as well as institutional food service establishments) sell or distribute fully prepared food. The added dimension of public and institutional food service establishments is one of replacing home self-preparation by away-from-home, labor-employed preparation. The obvious effect on retail food stores and public food service establishments of a large shift in demand from one to the other does not imply a concurrent alteration in the previous supply stages, since the composition of input values for the two outlets may be closely parallel. The effects on previous stages of supply of demand shifts among the varying consumer outlets depend largely on the destination in terms of the kind of business within the broad subsets of consumer outlets.[1] If, for example, a 50-percent shift in demand from "in home" to "away from home" food consumption occurred, an increased need for restaurant labor and a decreased need for retail food store labor would result. But the previous supply stages would be either undisturbed or affected only indirectly by the shift. If, however, it were determined that restaurants received food products comprising a 15 percent higher proportion of processed foods than its counterpart "in home" or retail food stores, labor demand in the alterative production stage of supply would increase by 7.5 percent, or productivity of the existing labor would increase by the comparable amount.

---

[1] Smith, J.D. and Schechter, M.C. "The Flow of Food Products," January, 1974, pg. 6. A report on work in progress for the Food Patterns Study.

Static Analysis of Food Supply and Labor Utilization: 1965 and 1969[2]

The following comparisons of supply and labor values for the years 1965 and 1969 are static. They reflect a dynamic process at merely two periods. Furthermore, the short span of time, the limited number of observations, and errors in measurement qualify the conclusions.

Consumers' food expenditures are most heavily concentrated in consumer food outlets, retail food stores, and public food service establishments. In 1965 and 1969, the two combined accounted for 89 percent and 83 percent, respectively, of the total value of food and beverages consumed during the year. Public food service establishments gained 1 percent while retail food stores lost 6 percent of the total value of food and beverages consumed between 1965 and 1969. Comparing 1969 with 1965, one sees that the liquor store percentage of the whole for each year remained unchanged at 6 percent. The institutional sector, including private, state and federal institutions, accounted for 5 percent of the food and beverage consumption in 1965, but grew to 11 percent in 1969--a 6 percent increase in four years. In the labor market corresponding to consumer outlets, weekly man hours in the retail food stores' labor market increased by 8 percent, while weekly man hours in the public food service labor market increased by 9 percent in 1969 relative to 1965. The greater weekly man hours in public food services compared to retail food stores reflects the larger rate of increase in public food service sales relative to retail food stores assuming equal price increase rates in each sector. A comparative

---

[2] This analysis is based on Tables I, II, III, and IV.

analysis of 1965 and 1969 reveals that the product dissemination stage of food supply underwent substantial structural change. In 1965, distributors and middlemen account for 73 percent of the distribution of of shipments leaving the alterative production stage of supply, while in 1969 they accounted for 68 percent, a fall of 5 percent. Manufacture salemen and consumer outlets' forward vertical integration gained 8 percent in 1969 compared with 1965, accounting for 29 percent of the total value of shipments leaving alterative production. The alterative production stage of supply gained in dominance: its value added accounted for 34 percent of the total retail value of food in 1969 compared to 25 percent in 1965. Within this stage, the relative value of individual industries, except meat products which increased 2 percent, remained unchanged from 1965 to 1969. The commodity market stage of supply, which may include elements of initial source of supply from underspecification , lost a value-added-as-a-percentage-of-output of 13 percent between 1965 and 1969. Finally, the initial sources-of-supply stage remained comparatively constant as a percentage of the total retail value of food and beverages in 1965 and 1969. Farms accounted for 44 percent of the total retail value of food and beverages in 1965 and 42 percent in 1969. The percentage divergence is accounted for by a negative 1 percent export deficit in 1965, and a positive 1 percent import surplus of 1 percent in 1969. The fishery segment of the initial source of supply stage remained constant, accounting for 1 percent of the total retail value of food and beverage consumption in the United States for the years 1965 and 1969.

This report has presented an examination of the food supply system over the four-year period, 1965-69. Although some detail presented at each point in the supply system both in terms of food values and labor's contribution to those values, the principal purpose was to demonstrate changes in those values in the period chosen. While this "time-series method" provides a useful basis for extrapolating into the future, it is also useful to examine the food supply system in detail at a single point in time. This "cross sectional approach" qualifies the time-series projection by exposing the specific characteristics of the food supply system that may not be amenable to linear interpolation. (Because a child grows to be five feet tall by his twelfth birthday does not mean that he will be ten feet tall when he's 24.) The following section presents a detailed cross-sectional view of the food supply system at a single point in time.

The Flow of Food Products

Introduction

The food industry of the United States may be viewed as a flow of goods from their initial sources of supply through differing levels of alternative production and service to final consumer consumption. Food products may be consumed in one of two sectors, in the home or away from home. In either case the food products are fully processed when finally eaten. The relative question is, therefore, what is the comparative added values of food products received by homes and away from home food services to final consumption of prepared foods. By ascertaining the composition of food products received by both sectors in terms of relative levels of alternative production or processing, one can determine the measurable effects of demand shifts from one sector to another on the composition of the food industry labor force. If, for example, away from home eating places received food products comprising a 15-percent higher proportion of fresh foods than its counterpart home eating, a 10-percent shift in demand from in-home to away-from-home consumption would result in a 1.5 percent shift in food industry labor force from specific processing industry to restaurant preparation or processing of food products.[1] Functionable to the nature of consumption demand shifts, any one or all of the sectors may be measureably affected.

---

[1] This statement is very simplified. It assumes an initial size equality of the two sectors, an equality in the nature of the demand shifts, and an equality in the structure of and labor mobility in the food industy.

Resultant demand shifts may additionally alter the number and nature of the labor force required to supply the consumer-demanded or establishment-required food composition.

The objective of this report is to provide an overview of the market for food consumed away from home.[2] Part I of this report consists of a summary analysis of Phase II[3] of a two-part study of the market for food served away from home conducted as a joint effort by the U. S. Department of Agriculture and the food industry.[4] An additional summary analysis based on a tabulation of data[5] projecting the value of food and nonalcoholic beverages received by away from home eating places in 1969 is presented as Part II. These computations provide a breakdown of food groups into processed and unprocessed categories by kind of business. Part II provides a preliminary second step towards unveiling the composition of the market for food served away from home by further defining the diversification in the components of the away-from-home food market. This is a step toward the final explication of the food market, necessary in measuring the manifested effects on labor composition in the food industry resulting from changes in the food market.

---

[2] Aggregate data is used in this report.

[3] Van Dress, Michael G. The Food Service Industry: Type, Quantity and Value of Foods Used, 1969. U. S. Dept. of Agr., Stat. Bul. 476, Nov. 1971.

[4] Ibid. Van Dress, Michael G., and William H. Freund. The Food Service Industry: Its Structure and Characteristics, 1966. U. S. Dept. of Agr., Stat. Bul. 416, Feb. 1968.

[5] Van Dress, Michael G. The Market for Food Consumed Away from Home: Dollar Value Statistics, 1969. U. S. Dept. of Agr., Stat. Bul. 491, Sept. 1972.

A short, separate bibliography accompanies this section of the report.

Part I: A Summary of a Study on the Market for Food Served Away From Home[6]

Introduction. The objective of the study was to determine the type, quantity, and value of foods used by food service operators so as to provide better understanding of food demands and needs of this market on a commodity basis. Estimates presented show the quantity and value of individual foods and food groups received by food service operators in 1969.

Scope of the study. All outlets offering meals, snacks, or beverages for on-premise or immediate consumption were sampled, except those that operated in conjunction with elementary and secondary schools, the military services, federal hospitals, federal and state correctional institutions, in-transit feeding operations, and boarding houses. Food retail value of the food businesses sampled amounted to about $7.2 billion or wholesale $3.6 billion in 1969.

Magnitude of food service industry. The food service industry consists of in excess of 500,000 mass feeding operations. Retail value of food and nonalcoholic beverages comprising the market of food served away from home was estimated at $35 billion in 1969, up from $28 billion during 1966. Wholesale value for these items was about $16 billion.

---

[6] This Summary is based on U. S. Department of Agriculture Statistical Bulletin #476, Nov. 1971.

In 1969, the combined total of personal and nonpersonal expenditures for food plus the retail value of food donated to schools and needy persons by government agencies amounted to about $115 billion. The value of food moving through food service outlets accounted for $27.3 billion or 23.74 percent of the total retail value of food in 1969.

Major food groups and analysis. The composition of the food service industry's variety or mix of goods has been assigned to one of sixteen major homogeneous food groups. These are dairy products and ices; fats and oils; flour and cereal products: bakery products; beef; other red meats; poultry and eggs; fish and shellfish; sugar and sweets; vegetables; fruits; juices, ades, and drinks; beverages; soups, sauces, and gravies; prepared food and mixtures; and nuts, condiments, and leavenings. Despite the number of items in a group, a low number of products together account for 50 percent or more of the total quantity or dollar value of a group. In six of the sixteen major food groups, as few as two individual food items accounted for 50 percent or more of quantity and dollar value; a total of nine groups were represented by three or fewer items; and in all but one major food group, at least 50 percent of the quantity and dollar value was explained by fewer than six products. Of food products received, 23 each accounted for 400 million pounds or more and represented over one-half the estimated 37.2 billion pounds received by food service outlets in 1969. Twenty-four items each had a purchase value of more than $100 million and a combined total of $6.6 billion, or about 55 percent of total value of all purchases.

Kind of business and analysis. The kinds of businesses in the food service industry may be classified into two basic sectors, public and institutional. Establishments in the public sector exist primarily to sell a product or service for profit. Food service in the public sector may be provided as a subordinate department or facility, or as the major kind of business, one that derives the most revenue from food service activity. Public eating establishments include separate eating places; separate drinking places; drug or proprietary stores; retail stores; hotels, motels or tourist courts; recreation or amusement places; civic, social, or fraternal associations; factories, plants, or mills; and other public eating places.[7] In the institutional sector, the primary purpose of food service activity is viewed as rendering a service rather than a profit, although some may generate a profit. Food service in institutions is usually supportive. Institutions with food service include hospitals; sanatoria, convalescent, or rest homes; homes for children, handicapped, or mentally ill; colleges, universities, professional, or normal schools; and other institutions.

In 1969, establishments in the public sector accounted for 82 percent of the 37.242 billion pounds of food and nonalcoholic beverages received by the businesses surveyed, while the institutional sector accounted for 18 percent.

Size of operation. The increasing prominence of the food service industry in food marketing has been accompanied by an increase in the importance of larger outlets. Almost half the quantity of all foods received in 1969 was reported by establishments with gross food sales of $100,000 or more yearly. The relationship between food costs and use of specific food items became apparent when establishments were classified by size of operation. For example, in establishments with gross food sales under $20,000, beef represented less than 16 percent of the estimated value of all foods received in 1969; while for outlets with sales of $300,000 and over, beef represented nearly 26 percent of the value of all foods received.

---

[7] Such businesses as fraternal associations and publicly owned nursing homes could be classified in either sector.

Primary sources of supply. Institutional middlemen offering two or more product lines are the major suppliers of the food service industry and handled about 52 percent of the value of selected food transactions involving primary sources of supply in 1969. Single-line institutional middlemen supplied 17 percent of the value, while multiple-line foodstore middlemen provided 11 percent of the 85.38 percent of the market accounted for by all types of middlemen, considering only primary sources of supply. Retail foodstores, and parent enterprises and commissaries, each accounted for almost 6 percent of the dollar value of transactions in 1969.

Part II: The Value of Food and Nonalcoholic Beverages in Eating Places in 1969[8]

Introduction. The objective of this separate calculation of processed and unprocessed foods within each food group[9] by each kind of business is to derive a better understanding of the composition of the value of foods and nonalcoholic beverages received by away-from-home eating establishments for sale to consumers. Effects on the food industry from changes in the food market can thereby be more accurately examined.

---

[8] Based on U. S. Dept. of Agr., Stat. Bul. 491, Sept. 1972.

[9] Food groups as defined in Part I of this report were expanded by 2 groups.

Procedure. The tabulation of data showing the value of food and nonalcoholic beverages received by away-from-home eating places[10] provided the basic information from which the calculations in Part II were derived. The study includes 14 kinds of public and institutional food service establishments, each containing 18 separate product groups divided into processed food and unprocessed food values. The division between the processed and unprocessed food category was determined separately for each food group allowing for a minimum level of technology in each product area. The division was designed to show aggregate differences between food service establishments, as well as differences among individual food product compositions of the same product group within the several food service establishments. The processed/unprocessed categories delineate a relative level of processing within each food group and do not denote an absolute level of processing or cutoff along the sequential path of food product alteration. Fresh fluid milk, for example, was designated unprocessed since pasturization and homogenization was considered to represent a relatively minimal level of processing relative to its counterparts within the dairy products and ices product group.

Results. Operators of food service establishments represented in the survey purchased food and nonalcoholic beverages valued at $12.196

---

[10] U. S. Dept. of Agr., Stat. Bul. 491, Sept. 1972.

billion in 1969. The equivalent is more than 37 billion pounds of food with a retail value of $27.3 billion. Of the purchased value of $12.196 billion, $8.115 billion or 66.54 percent was accounted for by unprocessed foods and $4.081 billion or 33.46 percent was accounted for by processed foods. Comparing the percentage of processed to unprocessed foods between total public and total institutional food service establishments, the percentages are 49.22 percent and 56.46 percent for public and institutional establishments respectively. The outcome for separately compared kinds of establishments is quite different. For drug or proprietary stores the percentage of processed to unprocessed foods is 82.73 percent while for hotels, motels, or tourist courts the percentage is only 36,66 percent and for hopsitals the percentage of processed to unprocessed foods is 50.83 percent. Within the same product group there is wide variation in the percentage of processed to unprocessed products among individual kinds of establishments. For separate eating places the percentage for dairy products and ices is 25.21 percent while the percentage for hospitals is 10.12 percent and for colleges, universities, professional, or normal schools the percentage of processed to unprocessed products in the dairy products and ices product group is 58.14 percent.

Conclusion. The aggregation problem encountered in dealing with the total value figure of $12.196 billion representing all food and nonalcoholic beverages purchased by operators of food service establishments is eased by a division by processed and unprocessed valuations. These valuations must clearly be divested by an additional division of product groups and kinds of businesses, only after which is it potentially possible to examine the effects of food market alterations on the composition of the food industry.

With the inclusion of this cross-sectional analysis, we have laid the groundwork for projection by interpolation. Now we proceed to examine other types of projection techniques. The following section presents a Bureau of Labor Statistics employment model which projects gross national product (the aggregate of the nation's output) into the future and then distributes it into its component parts, including the part of particular interest to this study--food consumption.

Bibliography

1. Michael G. Van Dress and William H. Freund. Survey of the Market for Food Away from Home: A Preliminary Overview of Basic Tabulations. Econ. Res. Serv., U. S. Dept. Agr. (May, 1967), 45 pp.

2. Michael G. Van Dress and William H. Freund. Types of Food Service Offered and Number of Outlets in the Food Service Industry. Econ. Res. Serv., U. S. Dept. Agr., ERS-359 (October, 1967), 6 pp.

3. William H. Freund and Michael G. Van Dress. Food Service Equipment: Estimated Number of Units by Kind of Business. Econ. Res. Serv., U.S. Dept. Agr., ERS-392 (November, 1968), 12 pp.

4. Michael G. Van Dress and William H. Freund. The Food Service Industry: Its Structure and Characteristics, 1966. Econ. Res. Serv., U. S. Dept. Agr., Stat. Bul. 416 (February, 1968), 370 pp.

5. Michael G. Van Dress. The Food Service Industry: Type, Quantity and Value of Foods Used, 1969. U. S. Dept. Agr., Stat. Bul. 467 (November, 1971).

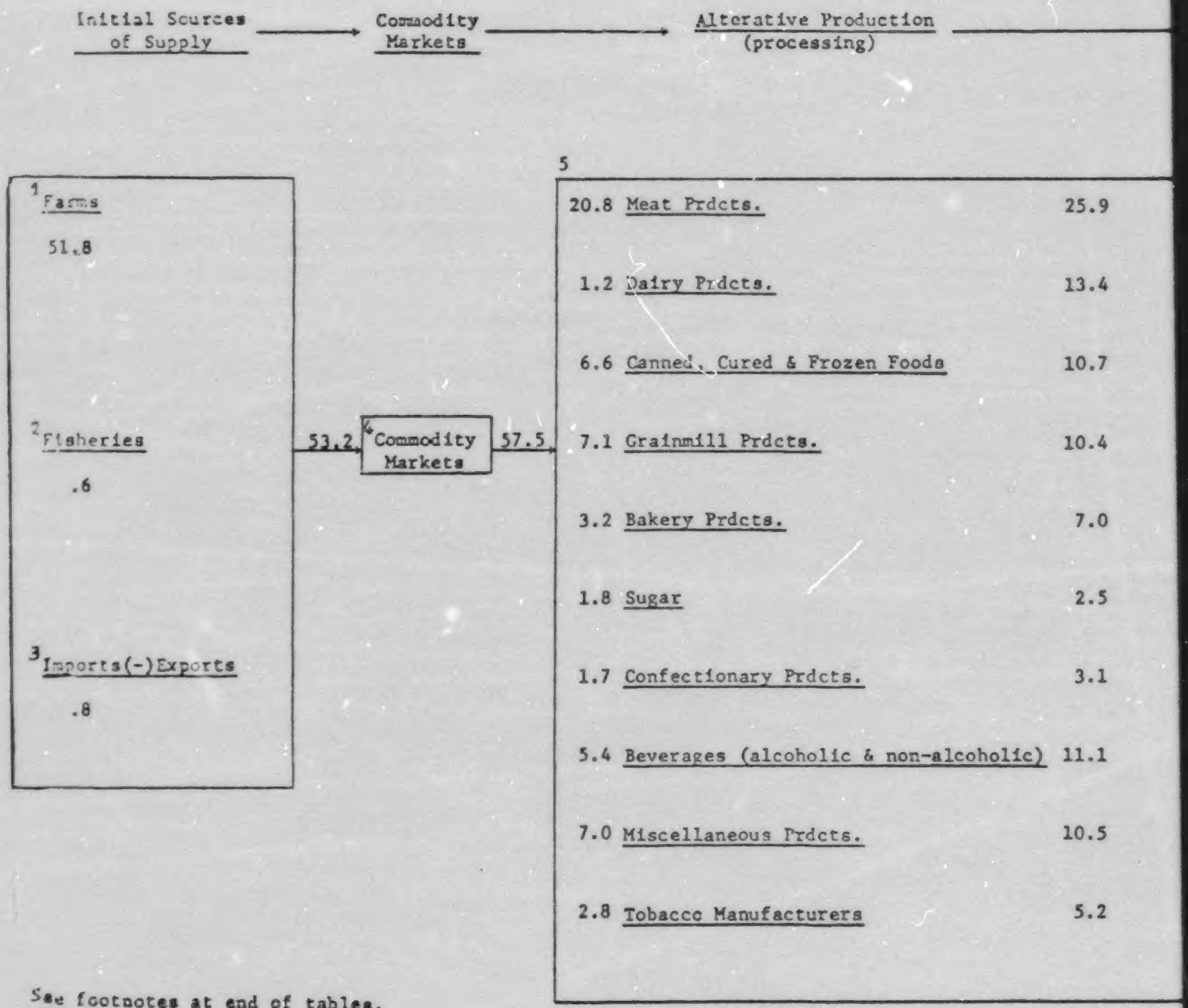
6. Michael G. Van Dress. Separate Eating Places: Type, Quantity and Value of Foods Used, 1969. U. S. Dept. Agr., Stat. Bul. 487 (June, 1972).

7. Michael G. Van Dress. The Market for Food Consumed Away from Home: Dollar Value Statistics, 1969. U. S. Dept. of Agr., Stat. Bul. 491, (September, 1972).

Appendix

Table I 1969 Supply Values (in billions of dollars)
Table II 1965 Supply Values (in billions of dollars)
Table III 1969 Labor Statistics
Table IV 1965 Labor Statistics

1969 SUPPLY VA

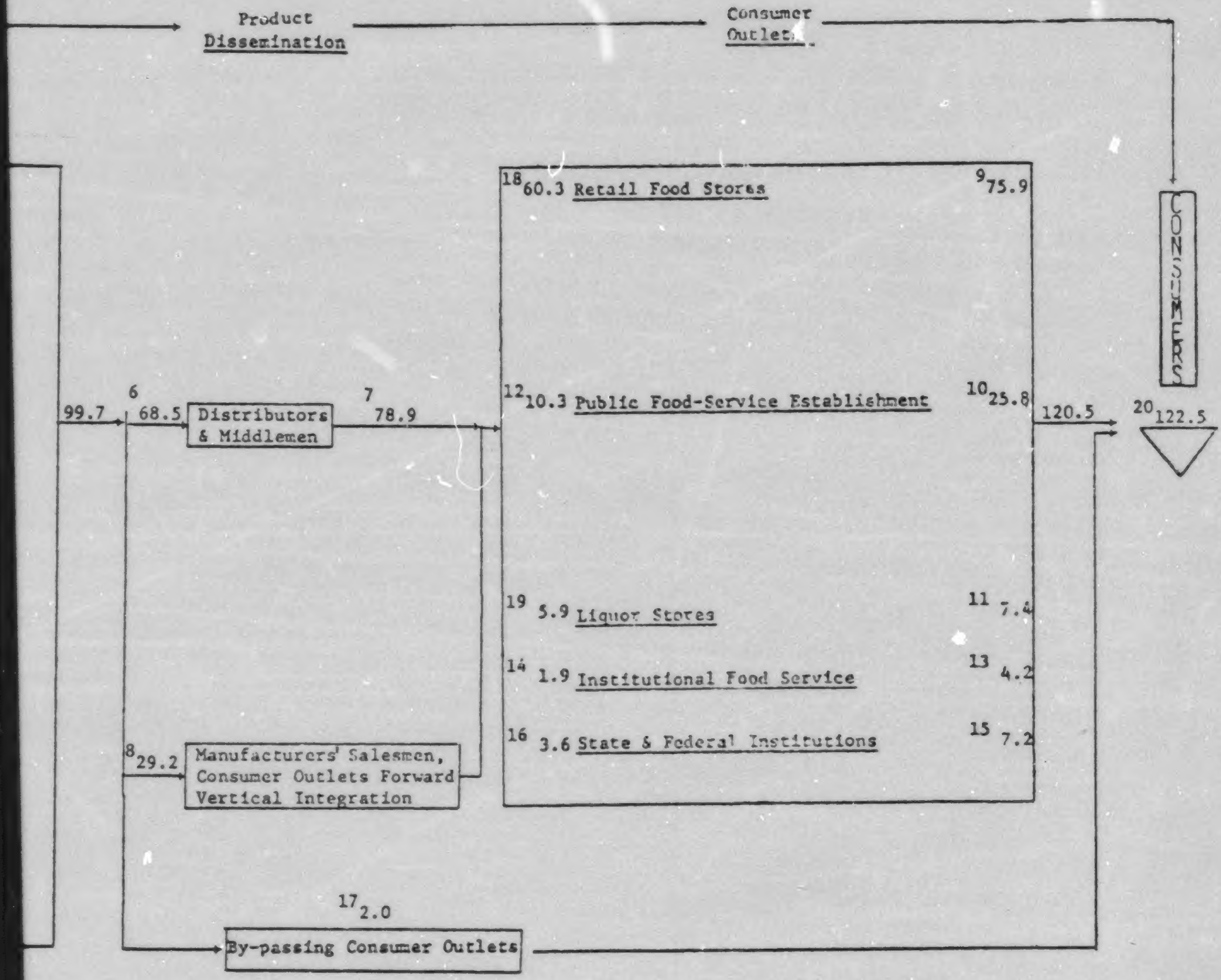


Initial Sources of Supply
Commodity Markets
Alterative Production (processing)
[1] Farms
51.8
[2] Fisheries
.6
[3] Imports(-)Exports
.8
53.2
[4] Commodity Markets
57.5
5
20.8 Meat Prdcts. 25.9
1.2 Dairy Prdcts. 13.4
6.6 Canned, Cured & Frozen Foods 10.7
7.1 Grainmill Prdcts. 10.4
3.2 Bakery Prdcts. 7.0
1.8 Sugar 2.5
1.7 Confectionary Prdcts. 3.1
5.4 Beverages (alcoholic & non-alcoholic) 11.1
7.0 Miscellaneous Prdcts. 10.5
2.8 Tobacco Manufacturers 5.2

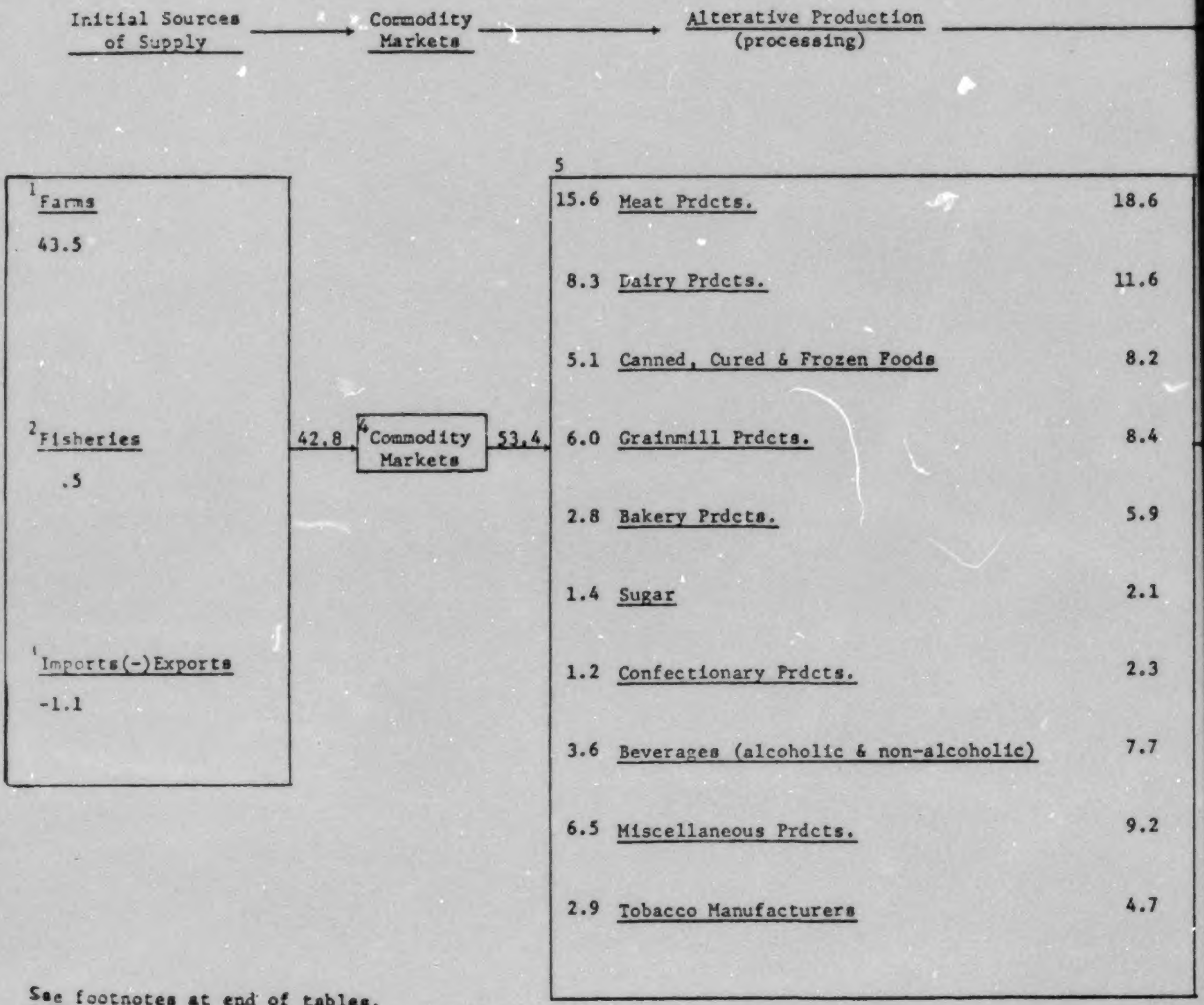
See footnotes at end of tables.

Numbers may not total due to rounding.

TABLE I
VALUES (in billions of dollars)


Product Dissemination
Consumer Outlets
CONSUMERS
99.7
6
68.5
Distributors & Middlemen
7
78.9
8
29.2
Manufacturers' Salesmen, Consumer Outlets Forward Vertical Integration
17
2.0
By-passing Consumer Outlets
18
60.3 Retail Food Stores
9
75.9
12
10.3 Public Food-Service Establishment
10
25.8
19
5.9 Liquor Stores
11
7.4
14
1.9 Institutional Food Service
13
4.2
16
3.6 State & Federal Institutions
15
7.2
120.5
20
122.5

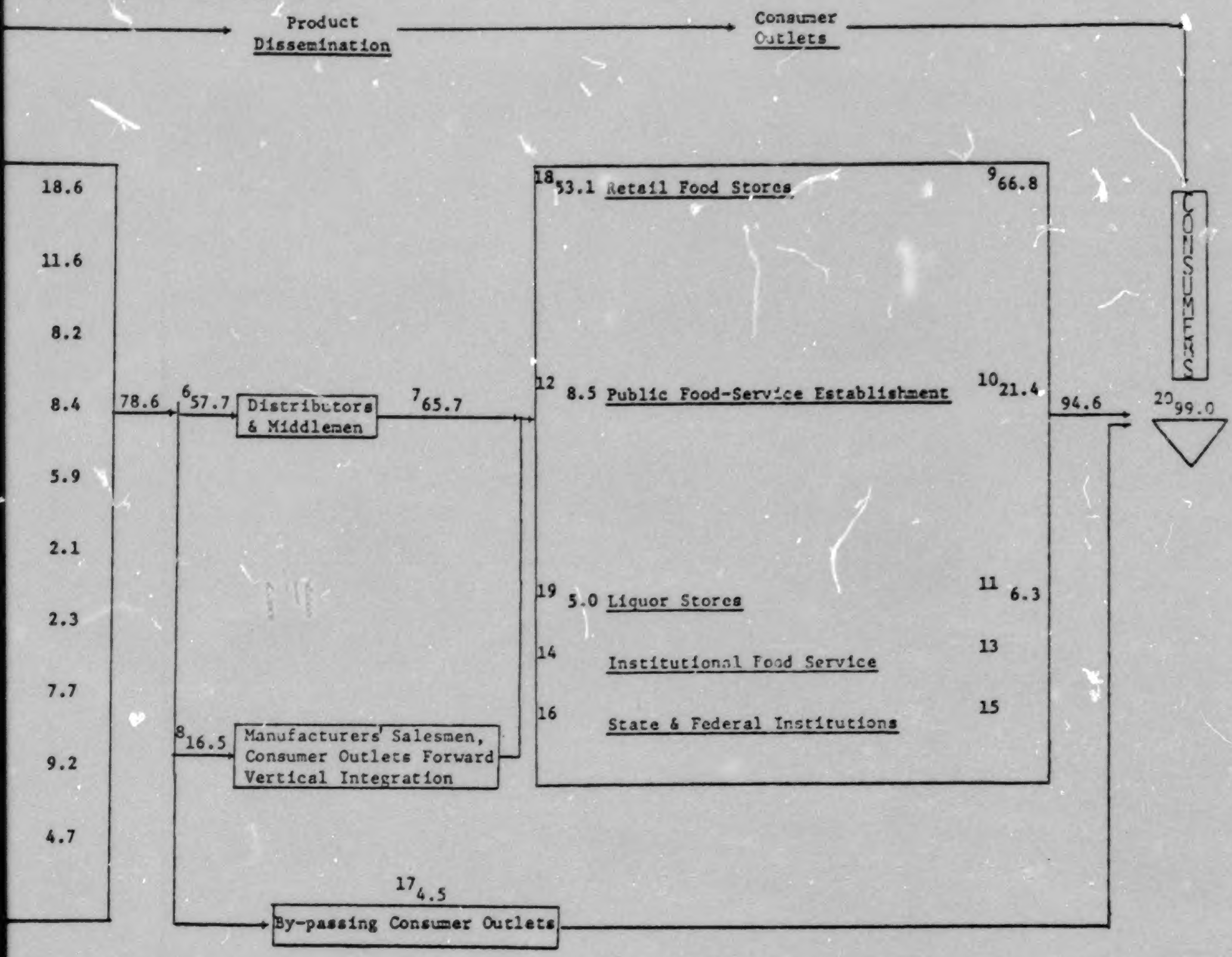
TABL
1965 SUPPLY VALUES (i


Initial Sources of Supply
Commodity Markets
Alterative Production (processing)
1 Farms
43.5
2 Fisheries
.5
1 Imports(-)Exports
-1.1
42.8
4 Commodity Markets
53.4
5
15.6 Meat Prdcts. 18.6
8.3 Dairy Prdcts. 11.6
5.1 Canned, Cured & Frozen Foods 8.2
6.0 Grainmill Prdcts. 8.4
2.8 Bakery Prdcts. 5.9
1.4 Sugar 2.1
1.2 Confectionary Prdcts. 2.3
3.6 Beverages (alcoholic & non-alcoholic) 7.7
6.5 Miscellaneous Prdcts. 9.2
2.9 Tobacco Manufacturers 4.7

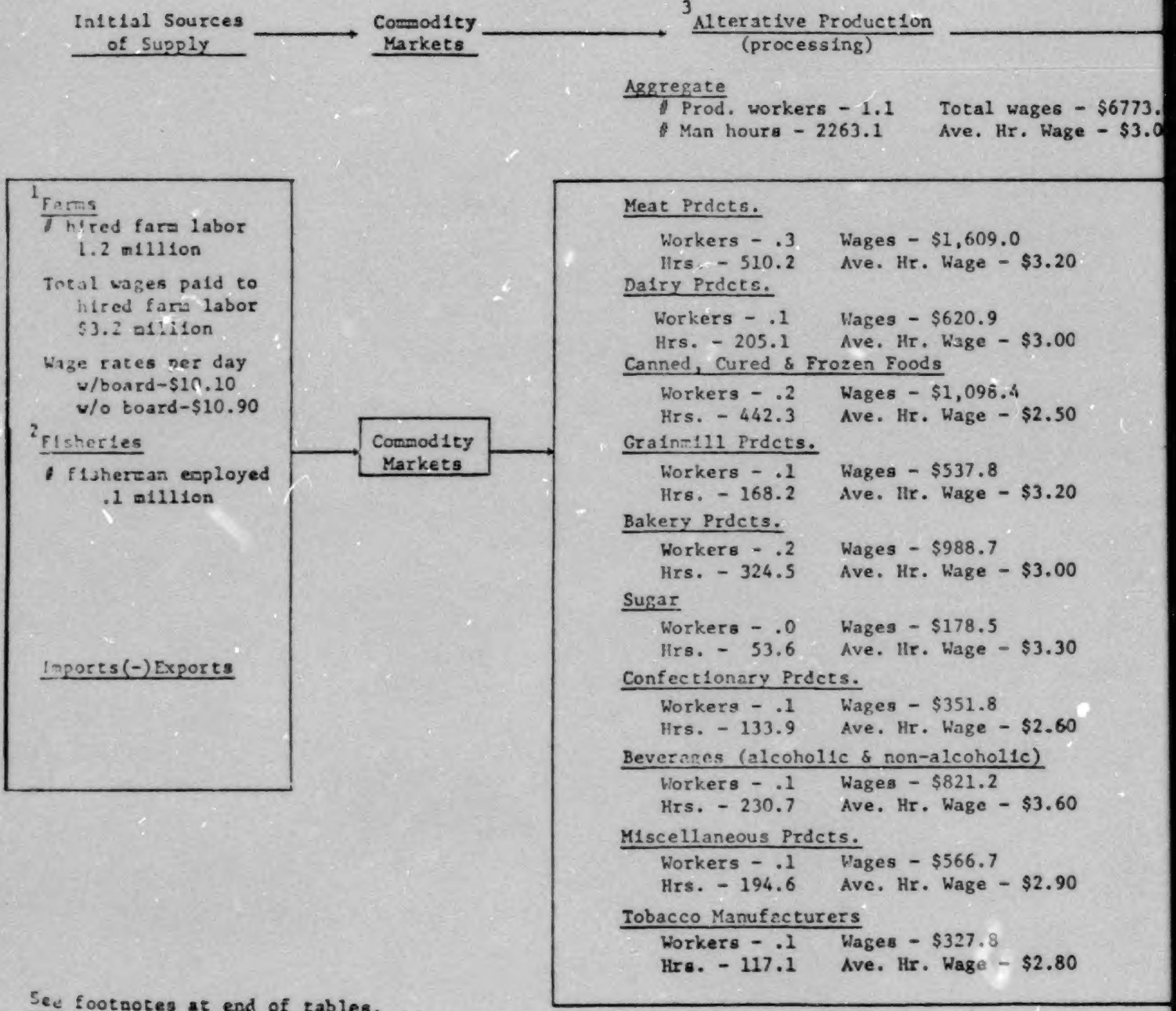
See footnotes at end of tables.

Numbers may not total due to rounding.

TABLE II
Y VALUES (in billions of dollars)


Product Dissemination
Consumer Outlets
18.6
11.6
8.2
8.4
5.9
2.1
2.3
7.7
9.2
4.7
78.6
6 57.7
Distributors & Middlemen
7 65.7
8 16.5
Manufacturers' Salesmen, Consumer Outlets Forward Vertical Integration
17 4.5
By-passing Consumer Outlets
18 53.1 Retail Food Stores
9 66.8
12 8.5 Public Food-Service Establishment
10 21.4
19 5.0 Liquor Stores
11 6.3
14 Institutional Food Service
13
16 State & Federal Institutions
15
94.6
20 99.0
CONSUMERS

1969



Initial Sources of Supply → Commodity Markets → [3] Alterative Production (processing)

Aggregate

# Prod. workers - 1.1 Total wages - $6773.

# Man hours - 2263.1 Ave. Hr. Wage - $3.0

[1] Farms

# hired farm labor 1.2 million

Total wages paid to hired farm labor $3.2 million

Wage rates per day
w/board-$10.10
w/o board-$10.90

[2] Fisheries

# fisherman employed .1 million

Imports(-)Exports

Commodity Markets

Meat Prdcts.

Workers - .3	Wages - $1,609.0
Hrs. - 510.2	Ave. Hr. Wage - $3.20

Dairy Prdcts.

Workers - .1	Wages - $620.9
Hrs. - 205.1	Ave. Hr. Wage - $3.00

Canned, Cured & Frozen Foods

Workers - .2	Wages - $1,096.4
Hrs. - 442.3	Ave. Hr. Wage - $2.50

Grainmill Prdcts.

Workers - .1	Wages - $537.8
Hrs. - 168.2	Ave. Hr. Wage - $3.20

Bakery Prdcts.

Workers - .2	Wages - $988.7
Hrs. - 324.5	Ave. Hr. Wage - $3.00

Sugar

Workers - .0	Wages - $178.5
Hrs. - 53.6	Ave. Hr. Wage - $3.30

Confectionary Prdcts.

Workers - .1	Wages - $351.8
Hrs. - 133.9	Ave. Hr. Wage - $2.60

Beverages (alcoholic & non-alcoholic)

Workers - .1	Wages - $821.2
Hrs. - 230.7	Ave. Hr. Wage - $3.60

Miscellaneous Prdcts.

Workers - .1	Wages - $566.7
Hrs. - 194.6	Ave. Hr. Wage - $2.90

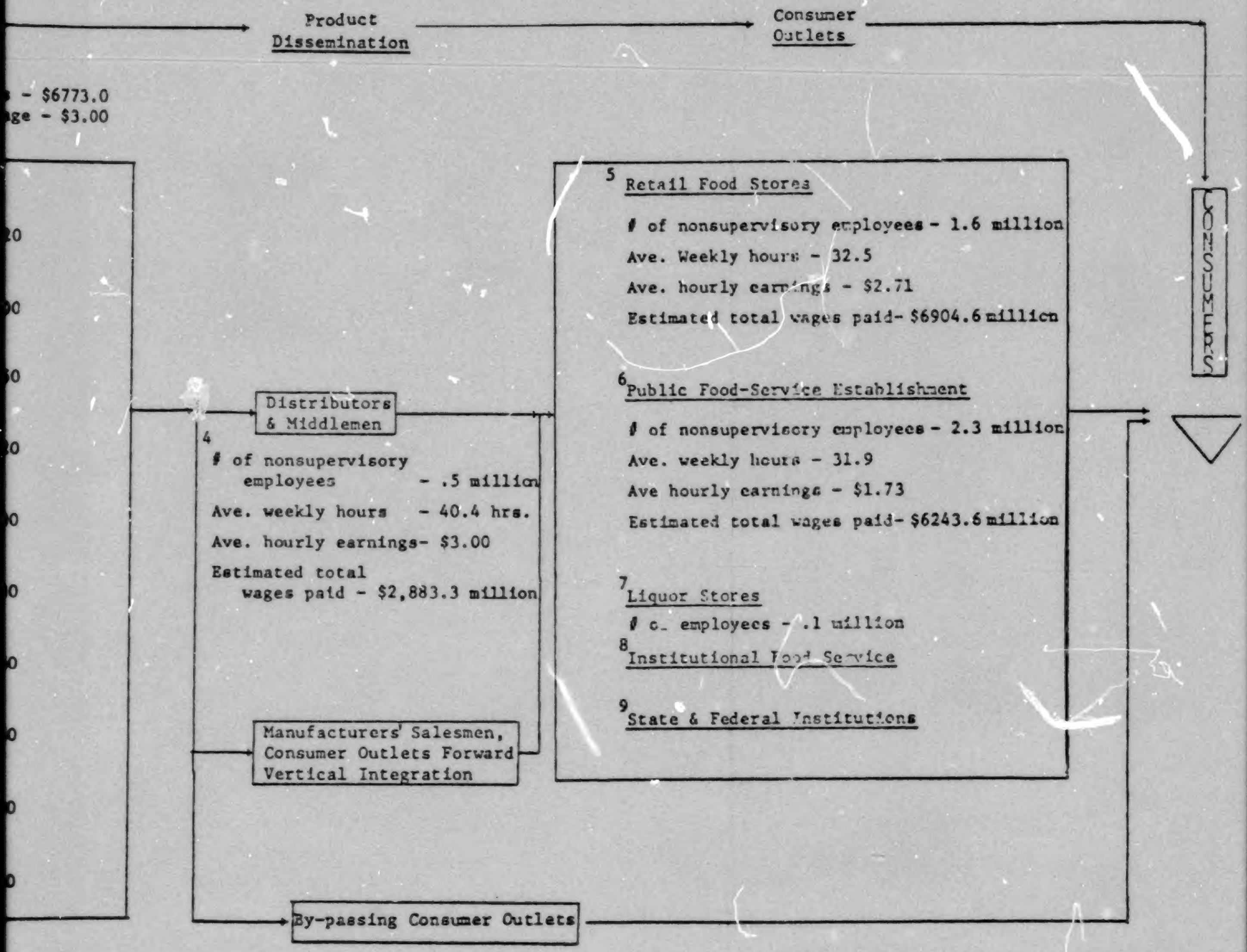
Tobacco Manufacturers

Workers - .1	Wages - $327.8
Hrs. - 117.1	Ave. Hr. Wage - $2.80

See footnotes at end of tables.

Numbers may not total due to rounding.

TABLE III
1969 LABOR STATISTICS


Product Dissemination
Consumer Outlets
CONSUMERS
- $6773.0
ge - $3.00
Distributors & Middlemen
Manufacturers' Salesmen, Consumer Outlets Forward Vertical Integration
By-passing Consumer Outlets

4

# of nonsupervisory employees - .5 million
Ave. weekly hours - 40.4 hrs.
Ave. hourly earnings- $3.00
Estimated total wages paid - $2,883.3 million

5 Retail Food Stores

# of nonsupervisory employees - 1.6 million
Ave. Weekly hours - 32.5
Ave. hourly earnings - $2.71
Estimated total wages paid- $6904.6 million

6 Public Food-Service Establishment

# of nonsupervisory employees - 2.3 million
Ave. weekly hours - 31.9
Ave hourly earnings - $1.73
Estimated total wages paid- $6243.6 million

7 Liquor Stores

# of employees - .1 million

8 Institutional Food Service

9 State & Federal Institutions

TABLE IV
1965 LABOR STATIS

Initial Sources of Supply → Commodity Markets → [3]Alterative Production (processing) →

Aggregate
# Prod. workers - 1.1 Total wages - $5429.2
# Man hours - 2214.0 Ave. Hr. Wage - $2.50

[1]Farms
# hired farm labor
1.5 million

Total wages paid to
hired farm labor
$2.8 million

Wage rates per day
w/board-[illegible].40
2/o board-$7.60

[2]Fisheries
# fisherman employed
.1 million

Imports(-)Exports

→ Commodity Markets →

Meat Prdcts.
Workers - .2 Wages - $1275.1
Hrs. - 474.5 Ave. Hr. Wage - $2.70

Dairy Prdcts.
Workers - .1 Wages - $579.7
Hrs. - 238.6 Ave. Hr. Wage - $[illegible].40

Canned, Cured & Frozen Foods
Workers - .2 Wages - $804.1
Hrs. - 409.0 Ave. Hr. Wage - $2.00

Grainmill Prdcts.
Workers - .1 Wages - $429.3
Hrs. - 164.4 Ave. Hr. Wage - $2.60

Bakery Prdcts.
Workers - .2 Wages - $830.3
Hrs. - 332.3 Ave. Hr. Wage - $2.50

Sugar
Workers - .0 Wages - $151.3
Hrs. - 54.5 Ave. Hr. Wage - $2.80

Confectionary Prdcts.
Workers - .1 Wages - $269.8
Hrs. - 127.5 Ave. Hr. Wage - $2.10

Beverages (alcoholic & non-alcoholic)
Workers - .1 Wages - $644.0
Hrs. - 219.8 Ave. Hr. Wage - $2.90

Miscellaneous Prdcts.
Workers - .1 Wages - $445.7
Hrs. - 193.6 Ave. Hr. Wage - $2.30

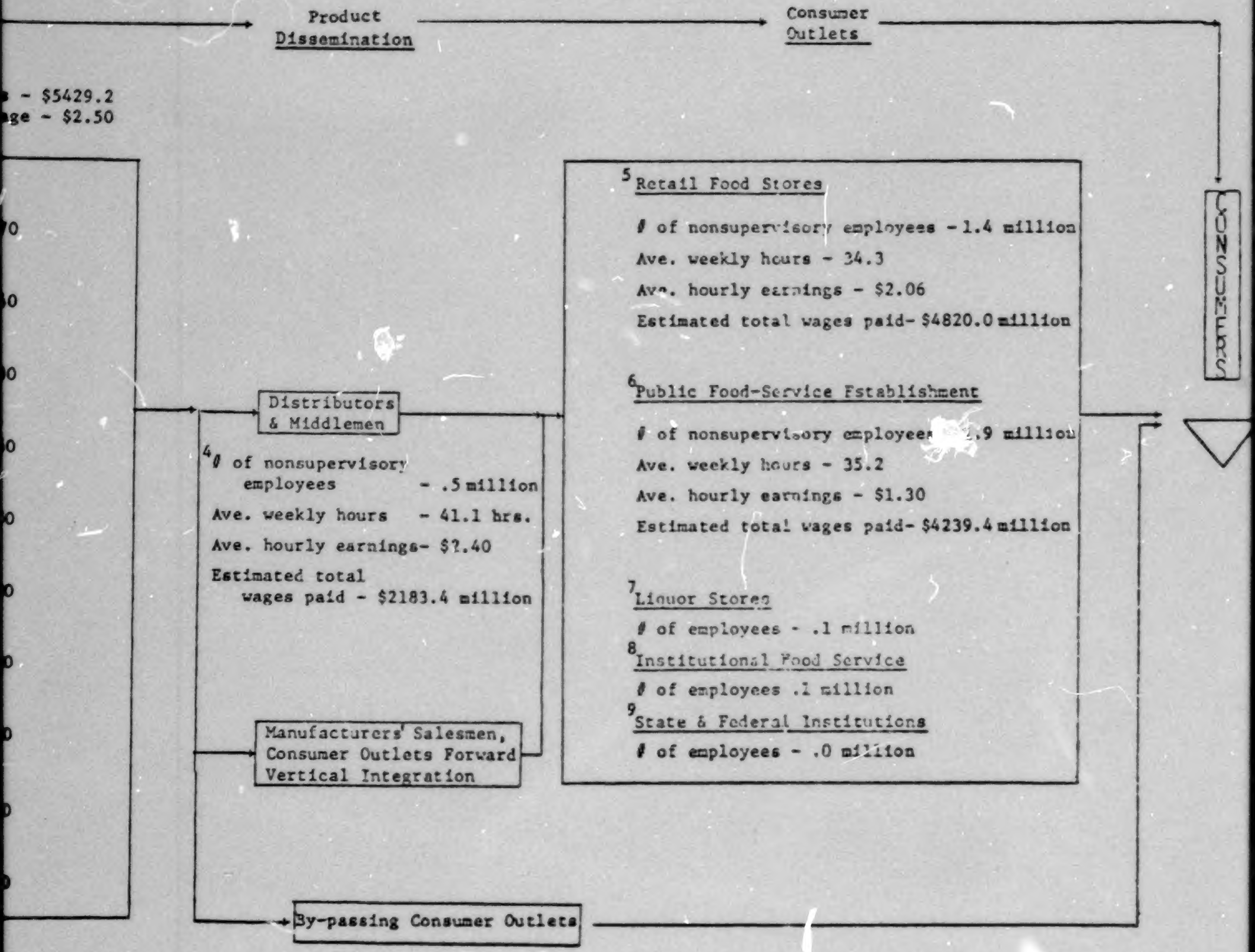
Tobacco Manufacturers
Workers - .1 Wages - $286.9
Hrs. - 125.7 Ave. Hr. Wage - $2.30

→

See footnotes at end of tables.

Numbers may not total due to rounding.

TABLE IV
1965 LABOR STATISTICS



Product Dissemination
Consumer Outlets
CONSUMERS
Distributors & Middlemen
Manufacturers' Salesmen, Consumer Outlets Forward Vertical Integration
By-passing Consumer Outlets

- $5429.2
ge - $2.50

[4] # of nonsupervisory employees - .5 million
Ave. weekly hours - 41.1 hrs.
Ave. hourly earnings- $2.40
Estimated total wages paid - $2183.4 million

[5] Retail Food Stores
# of nonsupervisory employees - 1.4 million
Ave. weekly hours - 34.3
Ave. hourly earnings - $2.06
Estimated total wages paid- $4820.0 million

[6] Public Food-Service Establishment
# of nonsupervisory employees [illegible].9 million
Ave. weekly hours - 35.2
Ave. hourly earnings - $1.30
Estimated total wages paid- $4239.4 million

[7] Liquor Stores
# of employees - .1 million

[8] Institutional Food Service
# of employees .1 million

[9] State & Federal Institutions
# of employees - .0 million

Footnotes for Table I and II

1. Statistical Abstracts of U. S., 1972, pg. 596, #987, total value of farm output including: cash receipts from farm marketings and CCC loans, farm products consumed directly in farm households, change in farm inventories, and gross rental value on farm houses ($2.3 and $2.8 billion in 1965 and 1969 respectively).

2. Statistical Abstract of U. S., 1972, pg. 633, #1068, Fisheries quantity and value of catch by states in regions--values represent the value of fish to fishermen.

3. Bus. Stat., 1971, pp. 112 and 117, Foreign Trade of the U. S. Value of imports and exports. Figures include food and live animals, beverages and tobacco. (For 1969 statistic.) Bus. Stat., 1967, pp. 112 and 117, corresponding to the previous (for 1965 statistic).

4. The value added in commodity markets was derived by subtacting the total value of the initial sources of supply from the total input value of alterative processing. The value added may be overstated as it may contain the values of initial sources of supply not determined, such as salt mining in addition to commodities bypassing alterative production such as fresh farm to store or home foods.

5. Annual Survey of Manufacturers, 1969, Table I, general statistics for industry groups. (For 1969 statistics). Annual Survey of Manufacturers, 1965, Table I, general statistics for industry groups. (For 1965 statistics). The value of the supply inputs were found by subtracting the value added by manufacture from the value of shipments which accounts for the output values.

6. Statistical Abstracts of U. S., 1972, pp. 750 & 751, #'s 1247 & 1250. Merchant wholesalers--estimated sales by kind of business and merchant wholesalers operating receipts and value added, respectively. The input figures for 1969 and 1965 were derived as follows. For 1969 the percentage value added from 1967 was multiplied against the 1969 estimated sales and then subtracted from 1969 estimated sales. For 1965, the percentage value added of 1963 & 1967 were averaged, then multiplied against the 1965 estimated sales and then subtracted from the 1965 estimated sales.

7. Statistical Abstracts of U. S., 1972, pg. 750, #1247. Merchant wholesalers estimated sales by kind of business 1960-1972. The figures used in Statistical Abstracts of U. S. were derived from U. S. Bureau of the Census, Monthly Wholesale Trade Report.

8. This value was derived by subtracting the value of food by passing consumer outlets and the value of food going into distributors and middlemen from the value of output from alterative production.

9. U. S. Dept. of Commerce, O.B.E. Business Statistics, 1971, pg.59. U. S. Dept. of Commerce, O.B.E. Business Statistics, 1967, pg. 57. Domestic trade--retail trade--food group stores (for 1965 statistic).

10. U. S. Dept. of Commerce, O.B.E. Business Statistics, 1971, pg. 59. Domestic trade--retail trade--eating and drinking places (for 1969 statistic). U. S. Dept. of Commerce, O.B.E. Business Statistics, 1967, pg. 57. Domestic trade--retail trade--eating and drinking places (for 1965 statistic). The eating and drinking place statistic includes restaurants found in hotels, amusement places, drug and proprietary stores in addition to restaurants found at other such places.

11. U. S. Dept. of Commerce, O.B.E. Business Statistics, 1971, pg. 59. Domestic trade--retail trade--liquor stores (for 1969 statistic. U. S. Dept. of Commerce, O.B.E. Business Statistics, 1967, pg. 57. Domestic trade--retail trade--liquor stores (for 1965 statistic).

12. U. S. Dept. of Agr. Stat. Bul. #491, Sept. 1972 (for 1969 statistic). The 1965 input value was derived by multiplying the percentage value of the 1969 input of the 1969 output against the 1965 output.

13. U. S. Dept. of Agr. Stat. Bul. #491, Sept. 1972. The total retail value of public food service establishments and institutional food service was given as $27.30 billion in 1969. The retail value of institutional food service establishments was derived by making a proportional division of the total retail value based on the determined proportion of wholesale values within the study. (For 1969 statistic, no statistic available for 1965.)

14. U. S. Dept. of Agr. Stat. Bul. #491, Sept. 1972. Total input food value of institutional food service for 1969 including: hospitals; sanatoria, convalescent, or rest homes, homes for children, the aged, handicapped or mentally ill; colleges, universities and normal schools, and other institutions. Figure excludes state, local, and federal government institutions (1965 statistic unavailable).

15. U. S. Dept. of Agr. Stat. Bul. #476, Nov. 1971. Figure includes military service, federal hospitals, federal and state correctional institutions, in-transit feedin operations and boarding houses. (For 1969 statistic, 1965 statistic unavailable.)

16. U. S. Dept. of Agr. Stat. Bul. #476, Nov. 1971. (For 1969 statistic unavailable.)

17. The value of food by passing consumer outlets was derived by subtracting the total retail value of consumer outlets from the total consumer expenditures on food and beverages.

18. National Commission on Food Marketing, report: Food from Farmer to Consumer, June 1966. Estimated the gross margin including retailers operating expenses and profits to be between 19 and 22 percent of sales depending on the firm and the services rendered. The statistic was derived by multiplying the average margin (20.5%) against the retail value and then subtracting that sum from the retail value.

19. National Commission on Food Marketing, report: Food from Farmer to Consumer, June, 1966. Ibid.,

20. U. S. Dept. of Commerce, O.B.E. Business Statistics, 1967 & 1971, pg. 1. National product, personal consumption of food and beverages.

NOTE: The combined value of #7 and #8 may be larger than the combined value of #12, #14, #16, #18, and #19 due to the understated value of #14 and #16 as a consequence of unavailable information.

Footnotes for Table III and IV

1. U. S. Dept. of L., B.L.S. Handbook of Labor Statistics. Table 45, Farm Employment and Wage Rates. U. S. Dept. of Commerce, Statistical Abstracts of U. S., 1972, Table 987. Farm Income and Expenses.

2. U. S. Dept. of Commerce, Statistical Abstracts of U. S., 1972, Table 1062, fisheries, employment, fishing craft, and establishments.

3. Annual Survey of Manufacturers, 1969, 1965, Table I, general statistics for industry groups. Average hourly wage was found by dividing wages by the number of man hours in each division.

4. U. S. Dept. of Labor, B.L.S. Bulletin #1312-9. Employment and Earnings, United States 1909-72, (sic 504)--groceries and related products. Estimated total wages paid was derived by multiplying average weekly hours against fifty weeks against average hourly earnings times the number of nonsupervisory employees. There is no distinction made for the type of wholesaling involved whether it be independent wholesalers or manufacturer salesmen or consumer outlets forward vertical integration.

5. U. S. Dept. of Labor, B.L.S. Bulletin #1312-9. Employment and Earnings United States 1909-72, (sic54) food stores. Estimated total wages paid was derived as follows: average weekly hrs. X 50 weeks X average hr. earning X # of nonsupervisory employees.

6. U.S. Dept. of Labor, B.L.S. Bulletin #1312-9. Employment and Earnings United States 1909-72, (sic 58) eating and drinking places. Estimated total wages paid was derived as follows: average weekly hrs X 50 weeks X average hr. earnings X # of nonsupervisory employees.

7. U. S. Dept. of Labor, B.L.S. Bulletin #1312-9. Employment and Earnings United States 1909-72, (sic592), liquor stores, figures do not include average weekly hrs. or weekly earnings.

8. U. S. Dept. of Labor, B.L.S. Bulletin #1553, 1966, hospitals. Includes labor involved in hospital food service (for 1965 statistic). Statistic not available for 1969.

9. U. S. Dept. of Labor, B.L.S. Bulletin #1553, 1966, hospitals. Includes labor involved in food service in state and local government run hospitals (for 1965 statistic). Statistic not available for 1969.

The Bureau of Labor Statistics (BLS) Employment Model

Introduction

To provide a framework for the future occupational outlook and thereby to direct the appropriate manpower allocation, the Bureau of Labor Statistics conducts a coordinated program which includes detailed projections of the labor force, aggregate and industry demand, output, employment, and occupational projections.

A short bibliography accompanies this section.

Overview of the BLS Employment Model

The construction of a projected economy is based primarily on the disaggregation and distribution of the projected economic activity or real Gross National Product for a specified year. The Bureau of Labor Statistics has focused its projections on three alternative years, 1970, 1980 and 1985. This potential real GNP is estimated as a multiple product by combining projections of total employment [labor force-- (unemployment rate x labor force)] with projections of annual hours per worker and output per man hour with separate estimates being made for the government and private sectors of the economy. Potential GNP is then distributed among expenditure components as the sum of private consumption, government consumption, private-domestic investment and net foreign demand. Private consumption is divided by 85 separate consumption functions into categories of consumer expenditures. The potential GNP, expressed as "final demand," is then distributed throughout the economy by an input-output system which translates such final demands as the demand for food into the outputs required from all industries, regardless of the degree to which the industries' products are sold directly to consumers. The total output requirements for each industry can then be computed as the sum of final and intermediate demand. To obtain the projected industry employment, output requirements are equated with the employment necessary to produce that amount of output, given output per man hour and annual hours per worker. The aggregation of employment in each of the 87 industries should equal total employment previously defined as the labor force minus unemployment.[1] Industry employment is further disaggregated into projections of occupational requirements. Industry occupational matrices divide total U. S. employment into 160 occupations cross-classified by 116 industries. The matrices rely heavily upon the 1970 U. S. Census Bureau's Occupation by Industry Report[2] with attention accorded to employment data from a number of sources considered preferable to census data.[3] The occupational structure of each industry was projected from historical statistics, occupational trends between 1950 and 1970,[4] and other factors that might influence occupational structure like expected new technology and changes in products. In addition, employment in each industry was estimated using regression analysis with assumptions consistent with the overall model. Equations were developed which related industry wage and salary employment in the 1947-1969 period with different combinations of the primary economic variable considered strategic in determining long-run changes in aggregate employment with the combination of variables providing the best statistical tests selected as final estimates. Finally, industries were studied individually and factors expected to influence their future growth were examined. This approach especially suited industries in which past trends in employment were not indicative of future trends and for which the model provided unacceptable results of unreasonable employment projections or poor statistical tests.

---

[1] See Diagram I for diagramatic description of interrelationships, Dept. of Labor, BLS, Patterns of Economic Growth, Bul. #1672, 1970.

[2] U. S. Bureau of Census, U. S. Census of Population, 1960, Subject Reports, Occupation by Industry.

[3] U. S. Dept. of Labor, GLS, Bul. #1737, Tomorrow's Manpower Needs, pg. 5, 1971.

[4] U. S. Dept. of Labor, B.S, Report 305, Occupational Employment Statistics, Sources and Data, 1966.

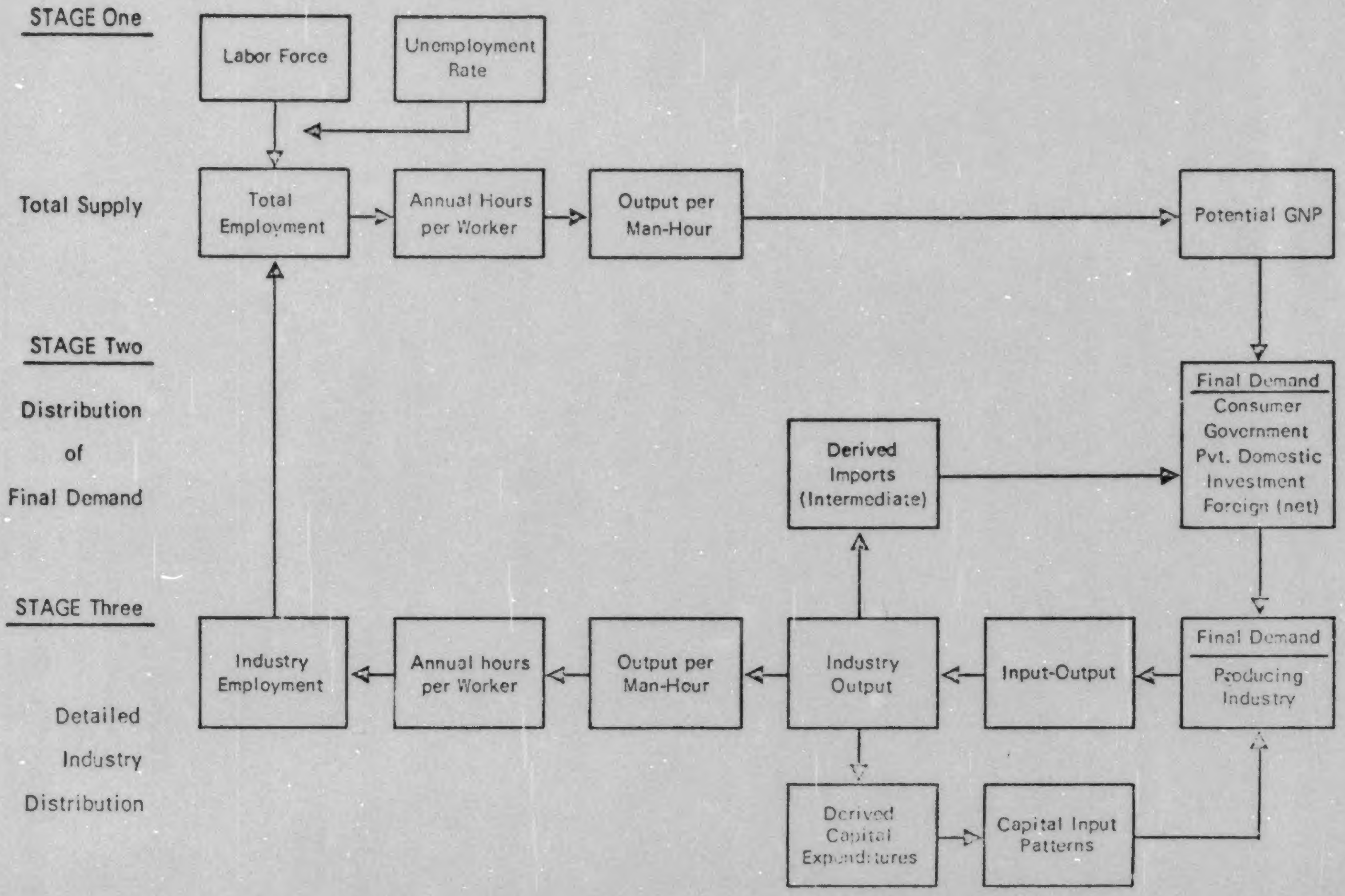
Results obtained from input-output analysis, individual industry studies, regression equations, and qualitative information concerning technology and the structure of the industry were used to determine employment projections for each industry. The projections were then reviewed to assure balance of productivity expectations, real GNP, and civilian labor force projections, as well as projections consistent with the overall assumptions of the model.

Assumptions, Terms, and Methodology

The simple outline of the BLS employment projection model described in the previous paragraphs afford a framework in which the assumptions, terms, and methodology of the model can be more rigorously examined.

Diagram

Interrelationship of Potential Gross National Product, Final Demand, Industry Production, Productivity, and Employment



STAGE One
Total Supply
STAGE Two
Distribution of Final Demand
STAGE Three
Detailed Industry Distribution
Labor Force
Unemployment Rate
Total Employment
Annual Hours per Worker
Output per Man-Hour
Potential GNP
Final Demand
Consumer
Government
Pvt. Domestic Investment
Foreign (net)
Derived Imports (Intermediate)
Final Demand
Producing Industry
Input-Output
Industry Output
Output per Man-Hour
Annual hours per Worker
Industry Employment
Derived Capital Expenditures
Capital Input Patterns

The estimates of target-year demand, output, and employment are projections. Therefore, they are functions of assumptions as to what the country will be like. Several assumptions have been used, but it is important to note that assumptions are alterable as conditions change. (The further projections are made into the future, the more suspect an assumption's validity.) The several assumptions include these: Fertility rates will be lower; the institutional framework of the American economy will not change radically; and economic, social, technological, and scientific trends will continue, including values placed on work, education, income and leisure.

We turn now to the employment projections generated by this model. The following section examines the trends of the 1960's utilized by the employment model. Then it proceeds to the model's food and food-service industry projections.

Bibliography

1. U. S. Dept. of Labor, BLS, "Patterns of Economic Growth," Bul. #1672 (1970).

2. U. S. Dept. of Commerce, U. S. Bureau of Census, U. S. Census of Population, Subject Reports, "Occupation by Industry." (1960).

3. U. S. Dept. of Labor, BLS, "Tomorrow's Manpower Needs," Bul. #1737 (1971), pg. 5.

4. U. S. Dept. of Labor, BLS, "Occupational Employment Statistics, Sources and Data," Report 305 (1966).

5. U. S. Dept. of Commerce, Survey of Current Business, "U. S. International Transactions." (June, 1969).

6. H. Houthakker and L.D. Taylor. Consumer Demand in the U. S., 1929-70, Vol. 126 (Cambridge Mass.: Harvard University Press, 1966).

The U. S. Food Industry and Labor Force:

Projections to 1985

Introduction

The purpose of this section is to present an overview of the U. S. labor force, particularly as it applies to the food and food service industries.

Presented first is a short summary of the U. S. food and food service industry and its labor force as it existed in the 1960's--or what the labor force looked like in the past. The second part of the report projects the U. S. labor force to 1985--or what the labor force will look like in the future. In all cases, we have attempted to show the relationship between the projected labor force and the food and food service industries.

Other aspects of the U. S. economy affect the food industry and the labor force as well, these areas are also covered in this section and include (1) growth in population, (2) gross national product, and (3) per capita income and consumption.

Like the two preceding sections, this section contains a short bibliography.

The Food Industry and Labor Force: 1960's

The food processing industry. In 1965 personal consumption expenditures for food were about $85 billion. This amount represented almost 20 percent of all personal consumption expenditures, making food the largest single category of private personal consumption.[1]

The economic significance of the food manufacturing and processing industry becomes clearer when it is compared with other manufacturing industries. "Basic" industries like primary metals, motor vehicles, and petroleum are overshadowed by the food manufacturing and processing industry. Total employment in the food industry is almost 40 percent greater than in primary metals, more than twice that in motor vehicles and over ten times greater than in petroleum refining.

"Value added" in the food industry in 1963 was 32 percent greater than in primary metals, 54 percent greater than in motor vehicles, and more than five times greater than in petroleum refining. By these measures the food manufacturing and processing industry is the largest single segment of American industry.

The food manufacturing and processing industry has experienced substantial growth during the post-war period. Sales of corporations primarily engaged in the production of food and kindred products rose from $32.6 billion in 1947 to $57.5 billion in 1962, and increase of over 76 percent.[2] Part of this growth is attributable to growth in population and increased urbanization during this period, as well as an 11 percent increase in prices. However, a fundamental change occurred in the buying habits and tastes of consumers during this period. In earlier years, the housewife spent a great deal of time preparing meals from a relatively raw state of ingredients. During the 1960's and 1970's, a substantial part of the preparation of food began to be undertaken by the manufacturer. As a result, many products may be served with a minimum of home preparation, and the "value added" as a percent of sales for these processed foods is considerably higher than for the more traditional products.

---

[1] The Structure of Food Manufacturing--A Report by the Staff of the Federal Trade Commission, Technical Study #8, National Commission on Food Marketing, June 1966.

2. Ibid., p. 14

Retail food stores are the principal source of food for American consumers. In 1963, 75.1 percent of the value of food consumed in the U. S. came from retail food stores, compared with 18.3 percent for eating places, and 1.2 percent for food produced and consumed of farms.[3]

There are more retail food stores in the U. S. than any other type of retail store, except eating and drinking places. When classified together, retail food stores and eating and drinking places accounted for 18.7 percent of all retail establishments in 1963, compared with 12.4 percent for gasoline stations, 6.8 percent for apparal and assessory stores, and 5.8 percent for auto dealers.

The services industry. The nearly 9.7 million workers who were employed in the services industry in 1966 include a wide range of occupations. These include policemen, firemen, cleaning women, theatre ushers, barbers and laundresses. The largest group of service workers, however, are in occupations relating to food preparation and service.

---

[3] Organization and Competition in Food Retailing, Technical Study #7, National Commission of Food Marketing, June 1966.

TABLE 1

Employees on Nonagricultural Payrolls, by Industry Division, 1919–68

[In thousands]

Year and Month	Total	Mining	Contract construction	Manufacturing			Transportation and public utilities	Wholesale and retail trade			Finance, insurance, and real estate	Services	Government		
				Total	Durable	Nondurable		Total	Wholesale trade	Retail trade			Total	Federal	State and local
1919	27,088	1,133	1,021	10,659	------	------	3,711	4,514	------	------	1,111	2,263	2,676	------	------
1920	27,350	1,239	848	10,658	------	------	3,998	4,467	------	------	1,175	2,362	2,603	------	------
1921	24,382	962	1,012	8,257	------	------	3,459	4,589	------	------	1,163	2,412	2,528	------	------
1922	25,827	929	1,185	9,120	------	------	3,505	4,903	------	------	1,144	2,503	2,528	------	------
1923	28,394	1,212	1,229	10,300	------	------	3,882	5,290	------	------	1,190	2,684	2,607	------	------
1924	28,040	1,101	1,321	9,671	------	------	3,807	5,407	------	------	1,231	2,782	2,720	------	------
1925	28,778	1,089	1,446	9,939	------	------	3,826	5,576	------	------	1,233	2,869	2,800	------	------
1926	29,819	1,185	1,555	10,156	------	------	3,942	5,784	------	------	1,305	3,016	2,816	------	------
1927	29,976	1,114	1,608	10,001	------	------	3,895	5,908	------	------	1,367	3,168	2,915	------	------
1928	30,000	1,050	1,606	9,947	------	------	3,828	5,874	------	------	1,435	3,265	2,995	------	------
1929	31,339	1,087	1,497	10,702	------	------	3,916	6,123	------	------	1,509	3,440	3,065	533	2,532
1930	29,424	1,009	1,372	9,562	------	------	3,685	5,797	------	------	1,475	3,376	3,148	526	2,622
1931	26,649	873	1,214	8,170	------	------	3,254	5,284	------	------	1,407	3,183	3,264	560	2,704
1932	23,628	731	970	6,931	------	------	2,816	4,683	------	------	1,341	2,931	3,225	559	2,666
1933	23,711	744	809	7,397	------	------	2,672	4,755	------	------	1,295	2,873	3,166	565	2,601
1934	25,953	883	862	8,501	------	------	2,750	5,281	------	------	1,319	3,058	3,299	652	2,647
1935	27,053	897	912	9,069	------	------	2,786	5,431	------	------	1,335	3,142	3,481	753	2,728
1936	29,082	946	1,145	9,827	------	------	2,973	5,809	------	------	1,388	3,326	3,668	826	2,842
1937	31,026	1,015	1,112	10,794	------	------	3,134	6,265	------	------	1,432	3,518	3,756	833	2,923
1938	29,209	891	1,055	9,440	------	------	2,863	6,179	------	------	1,425	3,473	3,883	829	3,054
1939	30,618	854	1,150	10,278	4,715	5,564	2,936	6,426	1,684	4,742	1,462	3,517	3,995	905	3,090
1940	32,376	925	1,294	10,985	5,363	5,622	3,038	6,750	1,754	4,996	1,502	3,681	4,202	996	3,206
1941	36,554	957	1,790	13,192	6,968	6,225	3,274	7,210	1,873	5,338	1,549	3,921	4,660	1,340	3,320
1942	40,125	992	2,170	15,280	8,823	6,458	3,460	7,118	1,821	5,297	1,538	4,084	5,483	2,213	3,270
1943	42,452	925	1,567	17,602	11,084	6,518	3,647	6,982	1,741	5,241	1,502	4,148	6,080	2,905	3,174
1944	41,883	892	1,094	17,328	10,856	6,472	3,829	7,058	1,762	5,296	1,476	4,163	6,043	2,928	3,116
1945	40,394	836	1,132	15,524	9,074	6,450	3,906	7,314	1,862	5,452	1,497	4,241	5,944	2,808	3,137
1946	41,674	862	1,661	14,703	7,742	6,962	4,061	8,376	2,190	6,186	1,697	4,719	5,595	2,254	3,341
1947	43,881	955	1,982	15,545	8,385	7,159	4,166	8,955	2,361	6,595	1,754	5,050	5,474	1,892	3,582
1948	44,891	994	2,169	15,582	8,326	7,256	4,189	9,272	2,489	6,783	1,829	5,206	5,650	1,863	3,787
1949	43,778	930	2,165	14,441	7,489	6,953	4,001	9,264	2,487	6,778	1,857	5,264	5,856	1,908	3,948
1950	45,222	901	2,333	15,241	8,094	7,147	4,034	9,386	2,518	6,868	1,919	5,382	6,026	1,928	4,098
1951	47,849	929	2,603	16,393	9,089	7,304	4,226	9,742	2,606	7,136	1,991	5,576	6,389	2,302	4,087
1952	48,825	898	2,634	16,632	9,349	7,284	4,248	10,004	2,687	7,317	2,069	5,730	6,609	2,420	4,188
1953	50,232	866	2,623	17,549	10,110	7,438	4,290	10,247	2,727	7,520	2,146	5,867	6,645	2,305	4,340
1954	49,022	791	2,612	16,314	9,129	7,185	4,084	10,235	2,739	7,496	2,234	6,002	6,751	2,188	4,563
1955	50,675	792	2,802	16,882	9,541	7,340	4,141	10,535	2,796	7,740	2,335	6,274	6,914	2,187	4,727
1956	52,408	822	2,999	17,243	9,834	7,409	4,244	10,858	2,884	7,974	2,429	6,536	7,277	2,209	5,069
1957	52,894	828	2,923	17,174	9,856	7,319	4,241	10,886	2,893	7,992	2,477	6,749	7,616	2,217	5,399
1958	51,363	751	2,778	15,945	8,830	7,116	3,976	10,750	2,848	7,902	2,519	6,806	7,839	2,191	5,648
1959	53,313	732	2,960	16,675	9,373	7,303	4,011	11,127	2,946	8,182	2,594	7,130	8,083	2,233	5,850
1960	54,234	712	2,885	16,796	9,459	7,336	4,004	11,391	3,004	8,388	2,669	7,423	8,353	2,270	6,083
1961	54,042	672	2,816	16,326	9,070	7,256	3,903	11,337	2,993	8,344	2,731	7,664	8,594	2,279	6,315
1962	55,596	650	2,902	16,853	9,480	7,373	3,906	11,566	3,056	8,511	2,800	8,028	8,890	2,340	6,550
1963	56,702	635	2,963	16,995	9,616	7,380	3,903	11,778	3,104	8,675	2,877	8,325	9,225	2,358	6,868
1964	58,332	634	3,050	17,274	9,816	7,458	3,951	12,160	3,189	8,971	2,957	8,709	9,596	2,348	7,249
1965	60,832	632	3,186	18,062	10,406	7,656	4,036	12,716	3,312	9,404	3,023	9,087	10,091	2,378	7,714
1966	64,034	627	3,275	19,214	11,284	7,930	4,151	13,245	3,437	9,808	3,100	9,551	10,871	2,564	8,307
1967	66,030	618	3,203	19,434	11,422	8,012	4,271	13,613	3,538	10,074	3,217	10,060	11,616	2,719	8,897
1968	68,146	625	3,259	19,740	11,578	8,162	4,348	14,111	3,669	10,442	3,357	10,504	12,203	2,737	9,466
1967															
January	64,495	613	2,910	19,409	11,491	7,918	4,183	13,254	3,473	9,781	3,108	9,652	11,366	2,643	8,723
February	64,438	608	2,824	19,382	11,476	7,906	4,177	13,116	3,456	9,660	3,127	9,730	11,474	2,652	8,822
March	64,817	610	2,875	19,355	11,454	7,901	4,200	13,236	3,463	9,773	3,150	9,837	11,554	2,669	8,885
April	65,214	617	3,053	19,272	11,392	7,880	4,182	13,363	3,478	9,885	3,173	9,970	11,584	2,683	8,901
May	65,606	622	3,168	19,225	11,377	7,848	4,260	13,478	3,482	9,996	3,193	10,056	11,604	2,690	8,914
June	66,490	636	3,341	19,475	11,477	7,998	4,314	13,624	3,546	10,078	3,243	10,193	11,661	2,766	8,895
July	66,097	640	3,475	19,248	11,305	7,943	4,343	13,605	3,571	10,034	3,278	10,237	11,271	2,798	8,473
August	66,391	624	3,519	19,535	11,363	8,172	4,330	13,610	3,596	10,014	3,293	10,231	11,240	2,784	8,456
September	66,656	613	3,440	19,546	11,346	8,200	4,329	13,672	3,572	10,100	3,261	10,180	11,615	2,707	8,908
October	66,858	605	3,391	19,491	11,321	8,170	4,293	13,757	3,588	10,169	3,254	10,191	11,876	2,707	9,169
November	67,397	605	3,307	19,660	11,534	8,126	4,318	14,017	3,616	10,401	3,260	10,219	12,011	2,709	9,302
December	67,903	602	3,134	19,609	11,525	8,084	4,311	14,618	3,620	10,998	3,269	10,223	12,137	2,819	9,318
1968															
January	66,017	590	2,771	19,398	11,459	7,939	4,252	13,602	3,564	10,038	3,252	10,124	12,028	2,697	9,331
February	66,393	591	2,803	19,425	11,439	7,986	4,264	13,585	3,572	10,013	3,271	10,228	12,136	2,697	9,439
March	66,713	594	2,967	19,447	11,440	8,007	4,276	13,658	3,581	10,077	3,288	10,290	12,193	2,699	9,494
April	67,422	626	3,157	19,507	11,507	8,000	4,296	13,910	3,594	10,316	3,310	10,402	12,214	2,712	9,502
May	67,724	631	3,255	19,569	11,531	8,038	4,268	13,959	3,607	10,352	3,327	10,488	12,227	2,710	9,517
June	68,724	647	3,387	19,897	11,678	8,219	4,375	14,139	3,690	10,449	3,365	10,634	12,280	2,815	9,465
July	68,327	652	3,498	19,729	11,584	8,145	4,394	14,112	3,717	10,395	3,407	10,687	11,848	2,844	9,004
August	68,508	653	3,553	19,884	11,496	8,388	4,410	14,141	3,727	10,414	3,430	10,675	11,762	2,795	8,967
September	68,923	646	3,515	20,023	11,655	8,368	4,417	14,208	3,713	10,495	3,397	10,587	12,130	2,705	9,425
October	69,292	593	3,498	19,999	11,663	8,336	4,400	14,328	3,738	10,590	3,404	10,631	12,439	2,694	9,745
November	69,585	639	3,374	20,015	11,735	8,280	4,414	14,561	3,756	10,805	3,412	10,648	12,522	2,703	9,819
December	70,123	637	3,241	19,990	11,753	8,237	4,409	15,124	3,766	11,358	3,421	10,656	12,643	2,769	9,874

Note: Data include Alaska and Hawaii beginning 1959.

About 2.5 million people, or approximately three-tenths of all service workers, are employed in food preparation and service. This occupational group includes cooks and chefs, kitchen workers, waiters and waitresses, counter and fountain workers, and bartenders.[4] These workers are employed in hotels, restaurants, motels, and other institutions like hospitals, schools, and plant cafeterias. (See Table 1.)

1. Cooks and Chefs

About 650,000 cooks and chefs were employed in early 1967.[5] Most of them worked in restaurants, but large numbers were employed in public and private schools, in hotels, hospitals, government agencies, manufacturing plants, private clubs, and other types of establishments. Three out of five of these workers were women. About half of the cooks in restaurants and the great majority in schools and hospitals were women. Men out numbered women in hotels, motels, and private clubs; moreover, most head cooks and practically all chefs were men.

2. Waiters and Waitresses

More than 950,000 waiters and waitresses were employed in early 1967, and about seven out of eight were women.[6] The proportion of part-time workers was also high; approximately two out of five workers were employed fewer than 35 hours a week. About four-fifths of all workers in this occupational group were employed in restaurant, drug stores, and other retail establishments that serve food. Hotels and educational institutions also employed many waiters and waitresses.

---

[4] Occupational Outlook Handbook, Bulletin #1550, U. S. Department of Labor, Bureau of Labor Statistics, 1967.

[5] Ibid., p. 16.

[6] Ibid., p. 21.

Eating and drinking places. Wage studies have been done on several of the industries within the broad category of retail food establishments, among these is the Bureau of Labor Statistics study on "eating and drinking places."[7]

Straight-time wages of nonsupervisory employees in eating and drinking places in the U. S. averaged $1.37 an hour in April, 1967, 3 percent above the $1.33 an hour in October, 1966. Slightly more than one-fifth of the 1.5 million nonsupervisory workers covered by this survey received less than $1 an hour in April, 1967. The corresponding population was slightly more than one-fourth in October, 1966. Part of the decline in the proportion of workers receiving less than $1 per hour was due to the expanded coverage of the Fair Labor Standards Act, as amended in 1966. Tipped employees who consisted of one-third of the industry's work force accounted for two-thirds of the workers receiving less than $1 an hour.

Employer-paid wages of tipped employees averaged $1.09 per hour in April, 1967, compared with $1.51 an hour for untipped employees. The averages were $1.06 and $1.47 per hour respectively in October 1966. (See Table 2.) Eating and drinking establishments employed 1,526,261

---

[7] Industry Wage Study: Eating and Drinking Places, Oct. 1966 and April 1967, Bulletin #1585, U. S. Department of Labor, Bureau of Labor Statistics, April 1968.

TABLE 2

Number and Average Hourly Earnings[1] of Employees in Selected Nonmanufacturing Industries, 1965–67–

Eating and drinking places (October 1966 and April 1967)[2] [3]

Item	United States				Northeast				South				North Central				West			
	October 1966		April 1967		October 1966		April 1967		October 1966		April 1967		October 1966		April 1967		October 1966		April 1967	
	Number	Hourly Wages[1]	Number	Hourly Wages[1]	Number	Hourly Wages[1]	Number	Hourly Wages[1]	Number	Hourly Wages[1]	Number	Hourly Wages[1]	Number	Hourly Wages[1]	Number	Hourly Wages[1]	Number	Hourly Wages[1]	Number	Hourly Wages[1]
ALL AREAS																				
Nonsupervisory employees	1,523,923	$1.33	1,525,261	$1.37	422,045	$1.46	418,692	$1.52	377,705	$1.02	380,718	$1.06	448,978	$1.28	449,639	$1.30	275,198	$1.63	276,212	$1.65
Men	627,246	1.60	627,682	1.64	212,890	1.74	210,300	1.79	132,720	1.25	135,718	1.29	156,517	1.53	157,447	1.55	125,019	1.84	124,217	1.86
Women	896,677	1.14	897,579	1.18	209,156	1.18	208,392	1.24	244,985	.90	245,000	.94	292,358	1.15	292,192	1.17	150,179	1.48	151,995	1.49
Tipped employees[4]	512,241	1.06	516,429	1.09	171,904	1.11	169,092	1.16	105,918	.72	111,050	.76	145,108	1.00	145,600	1.03	89,221	1.44	90,627	1.45
Men	93,546	1.50	94,397	1.53	48,141	1.52	47,202	1.56	14,912	1.04	16,565	1.06	16,438	1.49	15,581	1.50	14,055	1.97	15,049	1.94
Women	418,695	.96	422,032	.99	123,763	.96	121,890	1.01	91,036	.67	94,485	.71	128,730	.94	130,079	.97	75,166	1.34	75,578	1.35
Nontipped employees	1,011,682	1.47	1,008,832	1.51	250,141	1.70	249,600	1.76	271,757	1.14	269,668	1.19	303,807	1.41	303,979	1.44	185,977	1.72	185,585	1.75
Men	533,700	1.62	533,285	1.66	164,749	1.80	163,098	1.86	117,808	1.28	119,153	1.32	140,179	1.53	[illegible]	[illegible]	110,964	1.82	109,168	1.85
Women	477,982	1.29	475,547	1.24	85,392	1.50	86,502	1.56	153,949	1.03	150,515	1.08	163,628	1.31	[illegible]	1.33	75,013	1.56	76,417	1.62
METROPOLITAN AREAS[5]																				
Nonsupervisory employees	1,188,441	1.39	1,192,622	1.43	365,183	1.49	364,234	1.55	258,553	1.07	264,705	1.12	329,618	1.35	[illegible]	1.38	235,087	1.66	235,294	1.68
Men	535,111	1.64	537,793	1.68	192,881	1.75	191,517	1.80	102,428	1.28	106,594	1.32	129,610	1.58	[illegible]	[illegible]	[illegible]	1.86	109,829	1.87
Women	653,330	1.19	651,829	1.23	172,302	1.20	172,717	1.26	156,125	[illegible]	158,111	.99	200,008	1.29	[illegible]	[illegible]	124,895	1.48	125,465	1.52
Tipped employees[4]	405,845	1.10	409,167	1.13	148,996	1.13	147,654	1.18	73,412	.73	77,594	.78	104,366	1.03	104,946	1.05	79,031	1.46	78,973	1.48
Men	86,079	1.51	86,977	1.54	45,305	1.50	44,719	1.55	12,790	1.05	13,634	1.09	14,200	1.53	14,063	1.53	13,764	1.96	14,570	1.93
Women	219,776	.99	322,190	1.02	103,691	.97	102,944	1.02	60,652	.67	63,960	.72	90,166	.95	90,883	.98	65,267	1.36	64,403	1.38
Nontipped employees	782,609	1.55	783,455	1.59	216,187	1.74	216,580	1.80	185,111	1.21	187,111	1.26	225,252	1.50	223,443	1.53	156,056	1.76	156,321	1.78
Men	449,052	1.66	450,816	1.70	147,576	1.82	146,807	1.88	89,638	1.31	92,960	1.36	115,410	1.59	115,790	1.62	96,428	1.84	95,259	1.80
Women	333,554	1.39	332,639	1.44	68,611	1.56	69,773	1.62	95,473	1.11	94,151	1.17	109,842	1.40	107,653	1.44	59,628	1.62	61,062	1.66
NONMETROPOLITAN AREAS																				
Nonsupervisory employees	335,482	1.10	332,639	1.13	56,862	1.26	54,458	1.32	119,152	.91	116,013	.93	119,357	1.09	121,250	1.11	40,111	1.47	40,918	1.49
Men	92,135	1.38	89,889	1.41	20,009	1.63	18,783	1.70	30,292	1.16	29,124	1.18	27,007	1.28	27,591	1.28	14,827	1.64	14,388	1.74
Women	243,347	.99	242,750	1.03	36,853	1.05	35,675	1.12	88,865	.83	86,889	.85	92,350	1.03	93,650	1.05	25,284	1.35	26,530	1.36
Tipped employees[4]	106,406	.91	107,262	.94	22,908	1.01	21,438	1.05	32,506	.71	33,456	.72	40,802	.94	40,714	.97	19,190	1.24	11,654	1.27
Men	7,487	1.40	7,420	1.40	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Women	98,919	.88	99,842	.91	20,072	.90	18,946	.95	30,384	.69	30,525	.70	38,591	.92	39,196	.96	9,899	1.21	11,175	1.23
Nontipped employees	229,076	1.19	225,377	1.22	33,954	1.42	33,020	1.49	86,645	.99	82,557	1.02	78,555	1.16	80,536	1.18	29,921	1.55	29,264	1.58
Men	84,648	1.38	82,469	1.41	17,173	1.61	16,291	1.68	28,170	1.17	26,193	1.20	24,769	1.28	26,076	1.29	14,536	1.67	13,909	1.72
Women	144,428	1.08	142,908	1.11	16,781	1.23	16,729	1.32	58,476	.90	56,364	.94	53,783	1.11	54,460	1.12	15,385	1.44	15,355	1.45
SELECTED OCCUPATIONS																				
Dishwashers	143,836	1.19	142,867	1.23	36,977	1.41	36,190	1.47	39,259	.88	38,675	.92	39,646	1.13	40,358	1.17	27,954	1.45	27,646	1.47
Men	105,916	1.27	105,314	1.32	32,943	1.43	32,426	1.49	24,410	.93	24,023	.99	24,119	1.20	24,982	1.23	24,444	1.47	23,913	1.49
Women	37,920	.96	37,553	1.00	4,034	1.23	3,764	1.25	14,849	.75	14,652	.79	15,527	1.03	15,374	1.07	3,510	1.29	3,733	1.32
Bartenders	93,879	2.03	92,922	2.05	38,303	1.92	38,219	1.96	10,049	1.78	10,251	1.77	25,920	2.08	25,406	2.09	19,607	2.34	19,016	2.34
Men	80,037	2.10	78,884	2.12	35,853	1.94	35,172	1.97	7,370	1.81	7,600	1.83	20,522	2.20	19,947	2.22	16,292	2.48	16,165	2.46
Women	13,842	1.62	14,038	1.66	2,450	1.67	3,047	1.74	2,679	1.57	2,651	1.59	5,398	1.59	5,459	1.62	3,315	1.67	2,851	1.71
Waiters and waitresses	572,017	.99	567,305	1.02	165,996	1.00	162,966	1.06	137,161	.74	138,995	.77	174,591	1.00	172,923	1.01	94,279	1.32	92,511	1.33
Men	59,088	1.11	57,861	1.14	26,382	1.19	25,091	1.23	14,299	.80	14,610	.81	13,091	1.20	12,785	1.24	5,316	1.35	5,345	1.36
Women	512,929	.98	509,444	1.01	139,604	.97	137,875	1.03	122,862	.74	124,295	.77	161,500	.98	160,138	.99	88,963	1.32	87,166	1.33

---

[1] Wage data exclude tips and the value of free meals, rooms, and uniforms, if any were provided, and premium pay for overtime and for work on weekends, holidays, and late shifts. Service charges added to customers' bills and distributed by the employer to his employees are included.

[2] The survey covered establishments with 4 workers or more classified as eating and drinking places (industry group 581) according to the 1957 edition of the *Standard Industrial Classification Manual* and supplements (U.S. Bureau of the Budget).

[3] The regions used in this study are: *Northeast*—Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont; *South*—Alabama, Arkansas, Delaware, District of Columbia, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia; *North Central*—Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin; and *West*—Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming. Alaska and Hawaii were not included in the study.

[4] Employees customarily and regularly receiving more than $20 per month in tips in addition to hourly wages shown.

[5] Standard Metropolitan Areas as defined by the U.S. Bureau of the Budget through April 1966.

nonsupervisory workers in April, 1967; nearly three-fifths of these workers were women. Tipped employees accounted for nearly one-half of the women, compared with 15 percent of the men.

Waiters and waitresses made up seven-eights of the tipped employees of eating and drinking places in April, 1967, bartenders accounted for most of the remainder. Seven-tenths of the waiters and waitresses also received free meals, usually one or two a day. The incidence of free meals was greater in metropolitan than in nonmetropolitan areas.

Hotels and motels. A second segment of the retail food industry on which a wage study has been done is the hotel and motel industry.[8]

Straight-time wages for nonsupervisory employees in year-round hotels, motels and tourist courts averaged $1.43 per hour in April, 1967, 4.5 percent above the $1.37 per hour average in October, 1966. About one-sixth of the 442,000 nonsupervisory workers employed in this industry in April, 1967, received wages of less than $1 per hour. The corresponding proportion in October, 1966 was one-fourth. Again, part of this reduction was due to the expanded coverage of the Fair Labor Standards Act as amended in 1966.

Tipped employees who made up about one-fifth of the industry's labor force accounted for over 50 percent of the workers receiving less than $1 per hour in April, 1967. Employer-paid wages of tipped employees averaged $1.07 an hour in April 1967, compared with $1.53 and hour for non-tipped employees. The corresponding averages were $1.03 and $1.47 in October 1966. For both periods wages varied by

---

[8] Industry Wage Study: Hotels and Motels, Oct. 1966 and April 1967, Bulletin #1587, U. S. Department of Labor, Bureau of Labor Statistics, April 1968.

TABLE 3

Number and Average Hourly Earnings [1] of Employees in Selected Nonmanufacturing Industries, 1965–67–

Hotels and motels (October 1966 and April 1967) [2] [3]

Item	United States				Northeast				South				North Central				West			
	October 1966		April 1967		October 1966		April 1967		October 1966		April 1967		October 1966		April 1967		October 1966		April 1967	
	Number	Hourly wages [1]	Number	Hourly wages [1]	Number	Hourly wages [1]	Number	Hourly wages [1]	Number	Hourly wages [1]	Number	Hourly wages [1]	Number	Hourly wages [1]	Number	Hourly wages [1]	Number	Hourly wages [1]	Number	Hourly wages [1]
ALL AREAS																				
Nonsupervisory employees	441,345	$1.37	442,130	$1.43	108,195	$1.56	106,779	$1.63	143,136	$1.07	150,643	$1.10	103,750	$1.34	98,261	$1.38	86,264	$1.67	86,447	$1.71
Men	195,656	1.55	198,286	1.60	53,553	1.74	52,582	1.79	59,890	1.22	64,531	1.29	41,832	1.48	40,426	1.52	40,381	1.88	40,747	1.92
Women	245,689	1.23	243,844	1.29	54,642	1.40	54,197	1.47	83,246	.96	86,112	1.00	61,918	1.25	57,835	1.28	45,883	1.50	45,700	1.52
Tipped employees [4]	96,877	1.03	99,393	1.07	27,431	1.08	26,233	1.11	29,607	.71	34,041	.80	20,473	.99	19,528	1.03	19,366	1.48	19,591	1.51
Men	44,318	1.14	46,121	1.18	12,648	1.22	12,335	1.26	14,356	.76	16,854	.83	8,129	1.06	7,551	1.12	9,185	1.70	9,381	1.74
Women	52,559	.93	53,272	.97	14,783	.95	13,898	.98	15,251	.67	17,187	.77	12,344	.94	11,977	.98	10,181	1.29	10,210	1.30
Nontipped employees	344,468	1.47	342,737	1.53	80,764	1.73	80,546	1.79	113,529	1.16	116,602	1.27	83,277	1.43	78,733	1.46	66,898	1.73	66,856	1.77
Men	151,338	1.67	152,165	1.72	40,905	1.90	40,247	1.95	45,534	1.36	47,677	1.45	33,703	1.58	32,875	1.61	31,196	1.93	31,366	1.97
Women	193,130	1.31	190,572	1.38	39,859	1.56	40,299	1.64	67,995	1.03	68,925	1.14	49,574	1.33	45,858	1.36	35,702	1.55	35,490	1.59
METROPOLITAN AREAS [5]																				
Nonsupervisory employees	332,957	1.46	331,986	1.51	81,793	1.66	80,472	1.72	99,509	1.12	105,085	1.22	78,803	1.40	73,211	1.44	72,852	1.74	73,218	1.77
Men	157,357	1.62	158,497	1.67	42,326	1.81	41,065	1.86	45,046	1.27	48,854	1.34	34,209	1.52	32,623	1.58	35,776	1.94	35,955	1.98
Women	175,600	1.31	173,489	1.37	39,467	1.50	39,407	1.57	54,463	1.00	56,231	1.11	44,594	1.30	40,588	1.34	37,076	1.56	37,263	1.58
Tipped employees [4]	72,088	1.09	73,247	1.13	19,341	1.17	18,299	1.20	20,809	.74	23,898	.81	15,062	1.00	14,034	1.03	16,876	1.53	17,016	1.56
Men	37,225	1.19	38,326	1.22	10,629	1.27	10,348	1.32	11,113	.79	13,016	.85	6,946	1.04	6,383	1.09	8,537	1.72	8,579	1.76
Women	34,863	.99	34,921	1.02	8,712	1.05	7,951	1.06	9,696	.67	10,882	.76	8,116	.96	7,651	.99	8,339	1.33	8,437	1.35
Nontipped employees	260,869	1.56	258,739	1.62	62,452	1.81	62,173	1.87	78,700	1.23	81,187	1.34	63,741	1.49	59,177	1.54	55,976	1.81	56,202	1.84
Men	120,132	1.76	120,171	1.81	31,697	1.99	30,717	2.04	33,933	1.43	35,838	1.52	27,263	1.65	26,240	1.69	27,239	2.00	27,376	2.04
Women	140,737	1.39	138,568	1.46	30,755	1.63	31,456	1.70	44,767	1.07	45,349	1.20	36,478	1.38	32,937	1.42	28,737	1.62	28,826	1.63
NONMETROPOLITAN AREAS																				
Nonsupervisory employees	108,388	1.12	110,144	1.18	26,402	1.28	26,307	1.35	43,627	.95	45,558	1.02	24,947	1.15	25,050	1.19	13,412	1.30	13,229	1.34
Men	38,299	1.26	39,789	1.32	11,227	1.48	11,517	1.54	14,844	1.06	15,677	1.12	7,623	1.25	7,803	1.28	4,605	1.42	4,792	1.47
Women	70,089	1.04	70,355	1.10	15,175	1.13	14,790	1.19	28,783	.89	29,881	.97	17,324	1.11	17,247	1.14	8,807	1.23	8,437	1.27
Tipped employees [4]	24,789	.84	26,146	.90	8,090	.85	7,934	.90	8,798	.65	10,143	.77	5,411	.96	5,494	1.03	2,490	1.19	2,573	1.18
Men	7,093	.89	7,795	.96	2,019	.95	1,987	.97	3,243	.65	3,838	.77	1,183	1.15	1,168	1.28	......	......	......	......
Women	17,696	.82	18,351	.88	6,071	.81	5,947	.88	5,555	.65	6,305	.78	4,228	.90	4,326	.96	1,842	1.11	1,773	1.06
Nontipped employees	83,589	1.20	83,908	1.26	18,312	1.47	18,373	1.54	34,829	1.02	35,415	1.10	19,536	1.21	19,556	1.23	10,922	1.32	10,654	1.38
Men	31,206	1.35	31,904	1.40	9,208	1.59	9,530	1.66	11,601	1.17	11,839	1.24	6,440	1.27	6,635	1.28	3,957	1.42	3,990	1.47
Women	52,383	1.11	52,004	1.17	9,104	1.34	8,843	1.41	23,228	.94	23,576	1.03	13,096	1.18	12,921	1.20	6,965	1.27	6,664	1.32
SELECTED OCCUPATIONS																				
Bellman [6a]	16,547	.83	16,693	.88	3,400	1.04	3,353	1.07	6,878	.58	7,452	.65	3,814	.89	3,467	.95	2,455	1.14	2,421	1.16
Chambermaids [6b]	103,103	1.19	101,363	1.25	23,502	1.43	22,817	1.51	34,721	.88	36,197	1.00	23,970	1.19	21,597	1.23	20,910	1.42	20,752	1.45
Waiters and waitresses	60,450	.93	60,899	.96	17,355	.94	16,265	.94	16,522	.64	18,205	.72	13,724	.91	13,513	.94	12,849	1.31	12,916	1.32
Men	13,020	1.00	13,363	.98	4,648	1.01	4,515	.97	3,603	.75	4,211	.77	2,125	.96	2,102	.95	2,644	1.37	2,535	1.39
Women	47,340	.91	47,536	.95	12,707	.91	11,750	.94	12,919	.61	13,994	.70	11,599	.90	11,411	.94	10,205	1.29	10,381	1.31

---

[1] Wage data exclude tips and the value of free meals, rooms, and uniforms, if any were provided, and premium pay for overtime and for work on weekends, holidays, and late shifts. Service charges added to customers' bills and distributed by the employer to his employees are included.

[2] The survey covered establishments with 4 workers or more and classified as year-round hotels, motels, and tourist courts (part of industry group 701) according to the 1957 edition of the *Standard Industrial Classification Manual* and supplements (U.S. Bureau of the Budget).

[3] The regions used in this study are: *Northeast*—Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont; *South*—Alabama, Arkansas, Delaware, District of Columbia, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia; *North Central*—Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin; and *West*—Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming. Alaska and Hawaii were not included in the study.

[4] Employees customarily and regularly receiving more than $20 per month in tips in addition to hourly wage shown.

[5] Standard Metropolitan Statistical Areas as defined by the U.S. Bureau of the Budget through April 1966.

[6] Virtually all workers were (a) men, (b) women.

region and size of community. (See Table 3.)

Men made up 45 percent of the industry's nonsupervisory work force in April, 1967. Nearly one-half of the work force in metropolitan areas were men, compared with slightly more than one-third in the smaller communities. Three-fourths of the tipped employees were waiters, waitresses, or bellmen. Slightly more than four-fifths of the waiters and waitresses received free meals, usually one or two a day, in April, 1967. The incidence of free meals was lower in non-metropolitan areas than in metropolitan areas.

The Food Industry and Labor Force: Projections

The projections presented in this report were gathered from several published studies on expected growth in the U. S. economy. The time period of the projections varied among the sources, some of the projections are for 1980, some for 1985, and some for 1990.

All of the projections presented were made under the assumptions of full employment (3 or 4 percent unemployment), a 3 percent rate of inflation, and no drastic changes in social or economic conditions like major wars, major changes in legislation, major food shortages, or changes in propensity of various age groups to join the labor force.

There are four areas covered in the projections: (1) projected growth in the labor force, (2) population, (3) GNP, and (4) per capita income and consumption.

The labor force. In general, the labor force is expected to grow at a faster rate between 1972 and 1980 than it did during the late 1960's. Then it will probably decline to a much slower rate of growth

Table 4

Total Population, Total Labor Force, and Labor Rates, by Age and Sex, Actual 1960 and 1970 and Projected 1980, 1985, and 1990

[Numbers in thousands]

Sex and age group	Total population, July 1					Total labor force, annual averages					Labor force participation rates, annual averages (percent of population in labor force)				
	Actual		Projected			Actual		Projected			Actual		Projected		
	1960	1970	1980	1985	1990	1960	1970	1980	1985	1990	1960	1970	1980	1985	1990
BOTH SEXES															
Total, 16 years and over	121,817	142,366	167,339	175,722	183,078	72,104	85,903	101,809	107,716	112,576	59.2	60.3	60.8	61.3	61.5
16 to 24 years	21,773	32,257	37,463	34,405	31,643	12,720	19,916	23,731	22,184	20,319	58.4	61.7	63.5	64.5	64.2
25 to 54 years	67,764	71,777	84,740	94,028	103,309	46,595	51,457	61,944	69,202	76,421	68.8	71.7	73.1	73.6	74.0
55 years and over	32,279	38,333	45,136	47,289	48,126	12,788	14,500	16,084	16,330	15,836	39.6	37.8	35.6	34.5	32.9
MEN															
Total, 16 years and over	59,420	68,641	80,261	84,285	87,911	48,933	54,343	62,590	66,017	68,507	82.4	79.2	78.0	78.3	78.4
16 to 19 years	5,398	7,649	8,339	7,141	7,045	3,162	4,395	4,669	3,952	3,901	58.6	57.5	56.0	55.5	55.4
16 and 17 years	2,880	3,937	4,111	3,515	3,373	1,322	1,840	1,887	1,603	1,530	45.9	46.7	45.9	45.6	45.4
18 and 19 years	2,518	3,712	4,228	3,626	3,672	1,840	2,555	2,781	2,359	2,371	73.1	68.8	65.8	65.1	64.6
20 to 24 years	5,553	8,659	10,666	10,325	9,021	4,939	7,373	8,852	8,455	7,404	88.9	85.1	83.0	82.5	82.1
25 to 34 years	11,347	12,601	18,521	20,540	21,040	10,940	11,974	17,523	19,400	19,853	96.4	95.0	94.6	94.4	94.4
35 to 44 years	11,878	11,303	12,463	15,403	18,378	11,454	10,819	11,851	14,617	17,398	96.4	95.7	95.1	94.9	94.7
45 to 54 years	10,149	11,283	10,781	10,630	11,922	9,568	10,487	9,908	9,744	10,909	94.3	92.9	91.9	91.7	91.5
55 to 64 years	7,564	8,742	9,776	9,874	9,424	6,445	7,127	7,720	7,716	7,307	85.2	81.5	79.1	78.1	77.5
55 to 59 years	4,144	4,794	5,263	5,125	4,787	3,727	4,221	4,553	4,421	4,112	89.9	88.0	86.6	86.2	85.9
60 to 64 years	3,420	3,948	4,513	4,745	4,637	2,718	2,906	3,172	3,295	3,195	79.5	73.6	70.3	69.4	68.9
65 years and over	7,530	8,355	9,710	10,386	11,081	2,425	2,164	2,058	2,082	2,135	32.2	25.8	21.2	20.0	19.3
65 to 69 years	2,941	3,139	3,633	3,852	4,065	1,348	1,278	1,289	1,322	1,365	45.8	40.7	35.5	34.3	33.6
70 years and over	4,590	5,256	6,077	6,534	7,016	1,077	886	769	760	770	23.5	16.9	12.7	11.6	11.0
WOMEN															
Total, 16 years and over	62,397	73,725	87,078	91,437	95,167	23,171	31,550	39,219	41,699	43,669	37.1	42.8	45.0	45.6	45.9
16 to 19 years	5,275	7,432	8,057	6,910	6,776	2,061	3,250	3,669	3,203	3,188	39.1	43.7	45.5	46.4	47.0
16 and 17 years	2,803	3,828	3,963	3,397	3,243	801	1,324	1,427	1,247	1,205	28.6	34.6	36.0	36.7	37.2
18 and 19 years	2,472	3,604	4,088	3,513	3,533	1,260	1,926	2,242	1,956	1,983	51.0	53.4	54.8	55.7	56.1
20 to 24 years	5,547	8,508	10,401	10,043	8,801	2,558	4,893	6,592	6,523	5,826	46.1	57.5	63.4	64.9	65.2
25 to 34 years	11,605	12,743	18,442	20,301	20,750	4,153	5,704	9,255	10,339	10,678	35.8	44.8	50.2	50.9	51.5
35 to 44 years	12,348	11,741	12,903	15,741	18,524	5,325	5,971	6,863	8,560	10,219	43.1	50.9	53.2	54.4	55.2
45 to 54 years	10,438	12,106	11,625	11,407	12,635	5,150	6,533	6,537	6,542	7,354	49.3	54.0	56.2	57.4	58.2
55 to 64 years	8,070	9,763	11,307	11,492	10,934	2,964	4,153	5,057	5,213	5,003	36.7	42.5	44.7	45.4	45.8
55 to 59 years	4,321	5,257	5,966	5,824	5,396	1,803	2,547	3,055	3,033	2,853	41.7	48.4	51.2	52.3	52.9
60 to 64 years	3,749	4,506	5,341	5,598	5,538	1,161	1,606	2,002	2,150	2,150	31.0	35.6	37.5	38.3	38.8
65 years and over	9,115	11,433	14,343	15,537	16,687	954	1,055	1,233	1,319	1,391	10.5	9.2	8.6	8.5	8.3
65 to 69 years	3,347	3,780	4,595	4,942	5,267	579	644	758	814	864	17.3	17.0	16.5	16.5	16.4
70 years and over	5,768	7,653	9,748	10,595	11,420	375	412	481	505	527	6.5	5.4	4.9	4.8	4.6

Chart#1 YEAR -TO- YEAR CHANGE IN TOTAL LABOR FORCE, 1951-1985

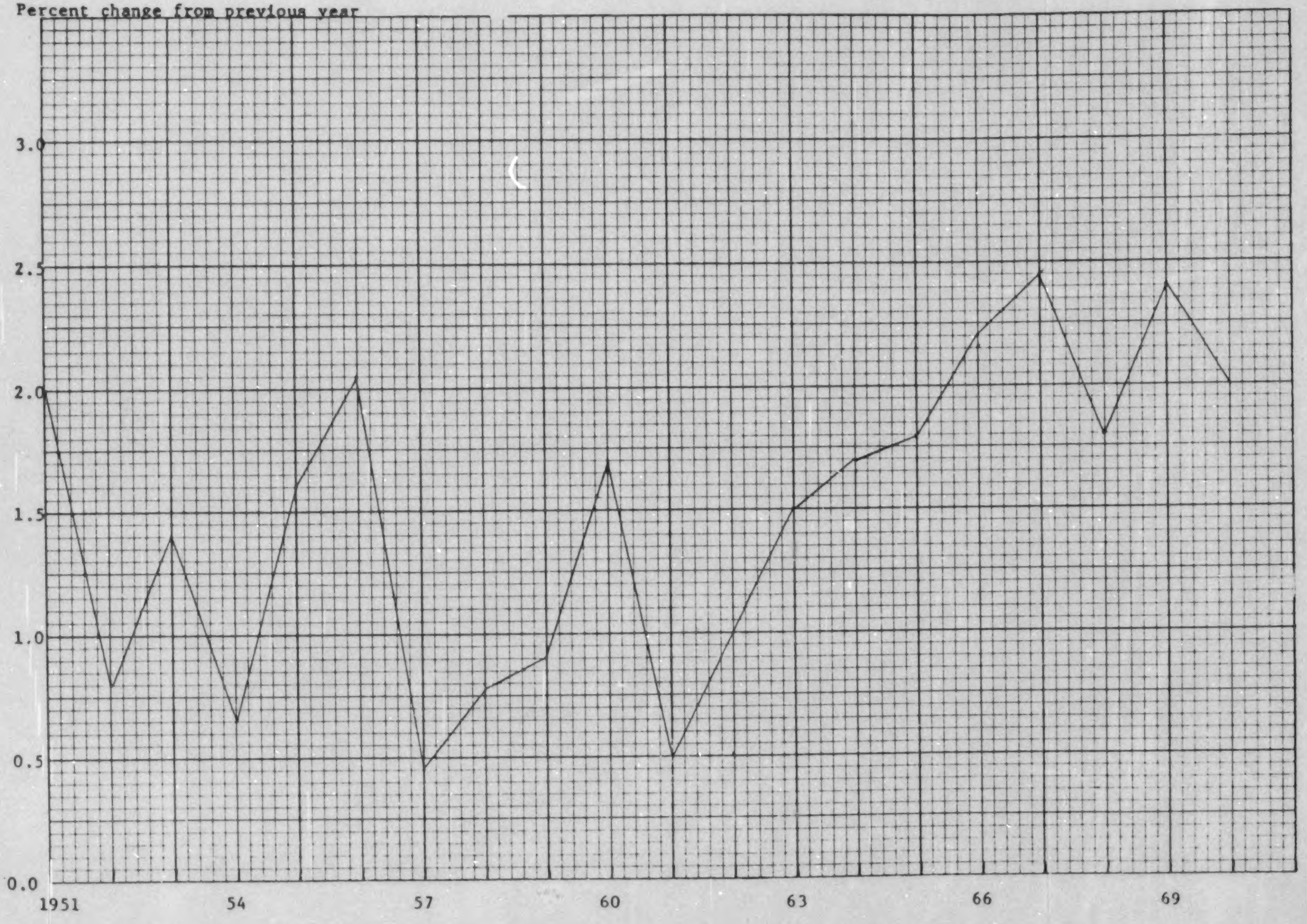
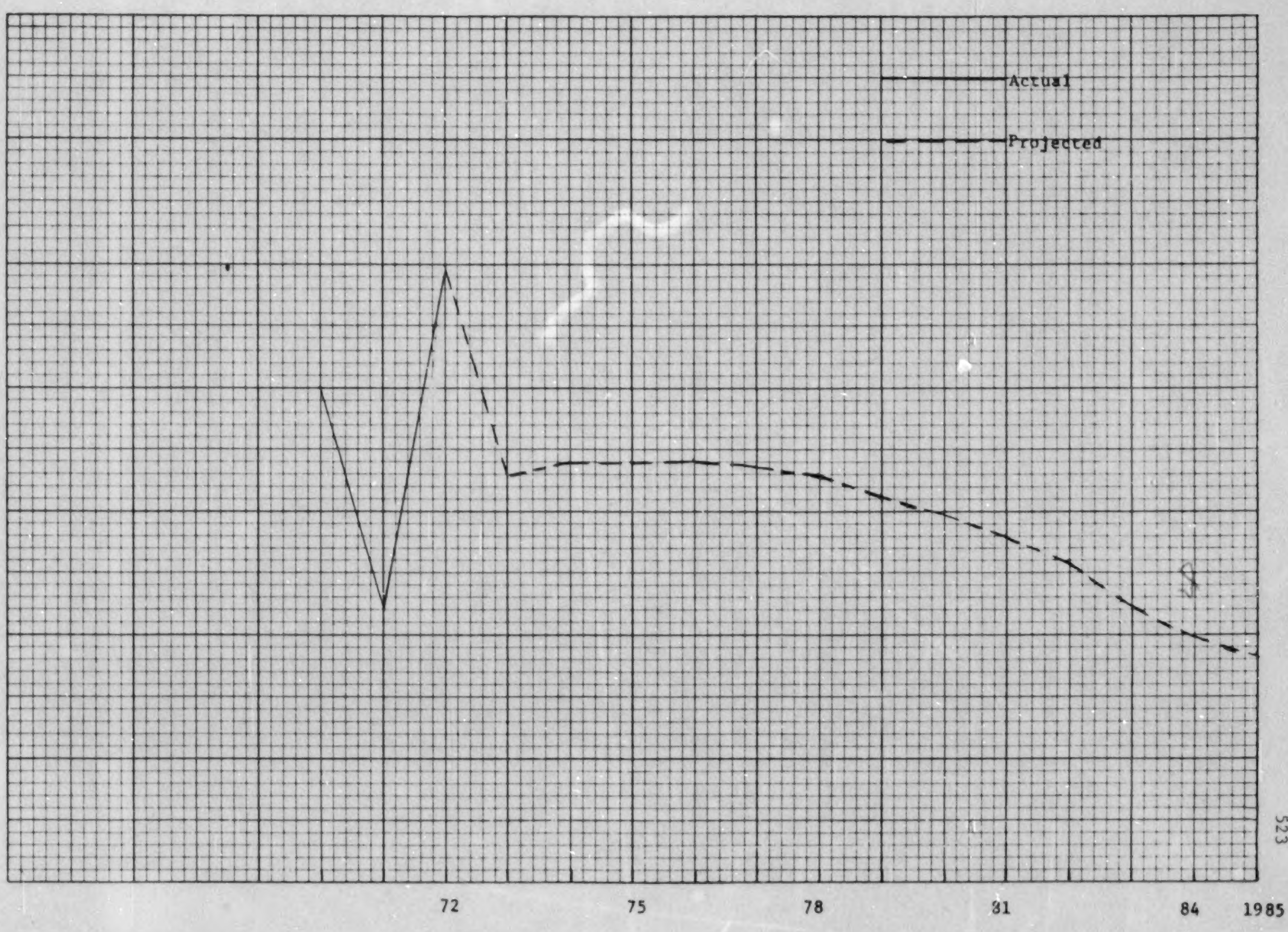


Chart 1 (continued)



from 1980 to 1985.

During the remainder of the 1970's, the U. S. labor force is expected to expand by 15.9 million, reaching 101.8 million by 1980. This represents an annual growth rate of 1.7 percent. After 1980, however, the rate of growth is expected to decline, averaging only 1.0 percent a year during the 1980's, and reaching a total of 107.7 million by 1985 and 112.5 million by 1990. (See Table 4.) The major reason for the decline in the labor force growth rate is the declining population growth rate.[9]

Chart #1 shows the annual change in the labor force from 1951 to 1985. Of particular interest is the slow-down in growth between 1980 and 1985, caused by a declining growth rate in population and leading to a slow-down in the growth rate of the GNP.

The median age of the labor force declined from 40 to 38 years during the 1960's and is expected to fall still more rapidly during the present decade, reaching 35 years of age by 1980. The major factor in this decline is the sharp rise in the number of young adult workers aged 20 to 34 years--from 17.7 million in 1970 to 26.8 million by 1980. This age group--one-fifth of the labor force in 1970--is expected to make up over one-fourth of the labor force by 1980.

During the period of 1980-85 the increase in the labor force is expected to occur mainly in the 35 to 54 age group--three-fourths of the projected growth in the labor force during this period is expected to be in this age class. The result of this expected shift in growth

---

[9] Denis F. Johnson. "The U. S. Economy in 1985: Population and Labor Force Projections," Monthly Labor Review, Dec. 1973, pp. 8-17.

Table 5

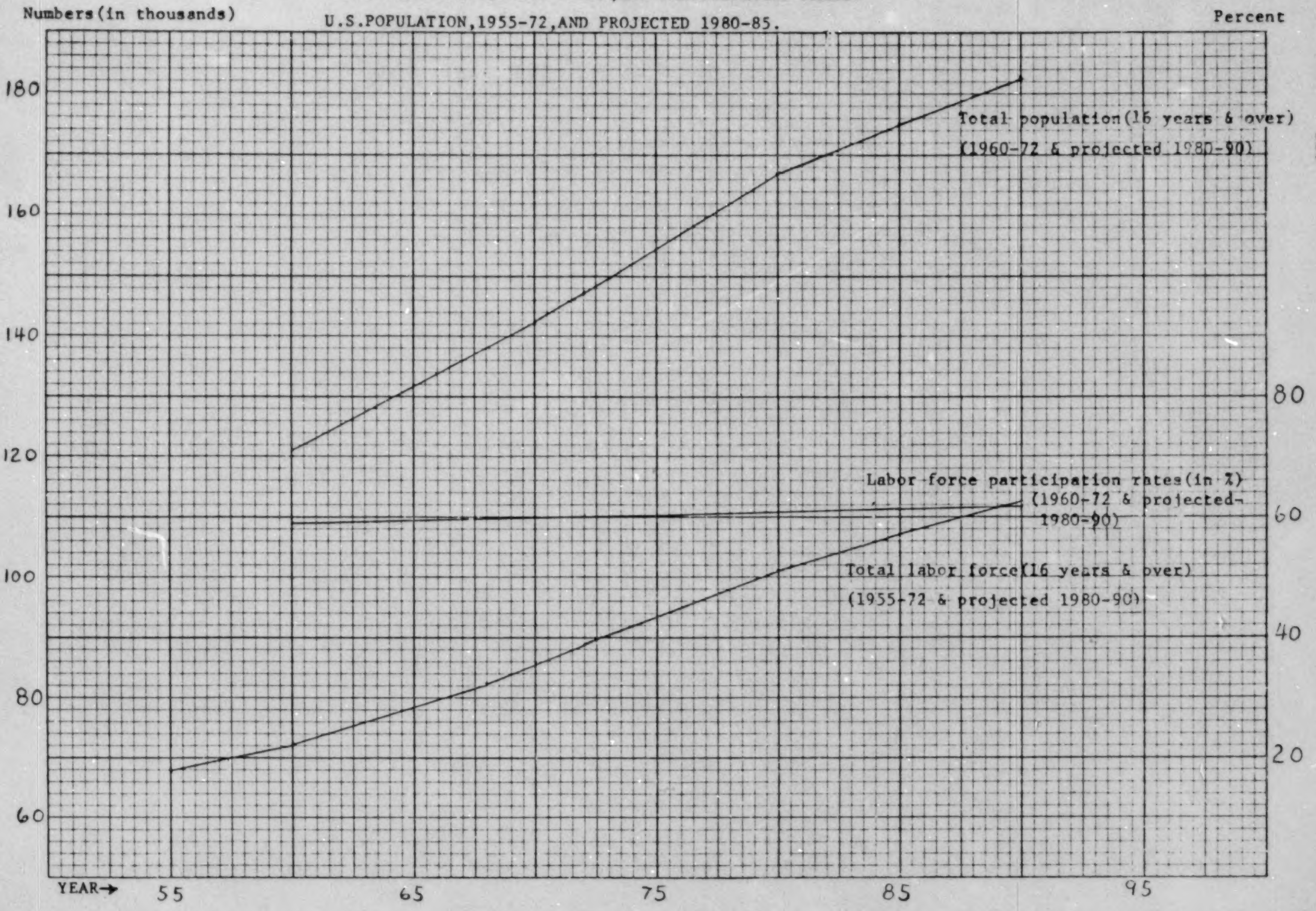
Distribution of Total Labor Force, by Age and Sex, Actual 196[illegible] and 1970 and Projected 1980, 1985, and 1990.

Sex and age group	Number (in thousands)					Percent distribution				
	Actual		Projected			Actual		Projected		
	1960	1970	1980	1985	1990	1960	1970	1980	1985	1990
BOTH SEXES										
Total, 16 years and over	72,104	85,903	101,809	107,716	112,576	100.0	100.0	100.0	100.0	100.0
16 to 24 years	12,720	19,516	23,781	22,184	20,319	17.6	23.2	23.4	20.6	18.0
16 to 19 years	5,223	7,645	8,337	7,165	7,039	7.2	8.9	8.2	6.7	6.3
20 to 24 years	7,497	12,271	15,444	15,019	13,230	10.4	14.3	15.2	13.9	11.8
25 to 54 years	46,596	51,487	61,944	69,202	76,421	64.6	59.9	60.8	64.2	67.9
25 to 34 years	15,099	17,678	26,779	29,739	30,531	20.9	20.6	26.3	27.6	27.1
35 to 44 years	16,779	16,789	18,720	23,177	27,617	23.3	19.5	18.4	21.5	24.5
45 to 54 years	14,718	17,020	16,445	16,286	18,273	20.4	19.8	16.2	15.1	16.2
55 years and over	12,788	14,500	16,034	16,330	15,836	17.7	16.9	15.8	15.2	14.1
55 to 64 years	9,409	11,280	12,787	12,929	12,310	13.0	13.1	12.6	12.0	10.9
65 years and over	3,379	3,220	3,297	3,401	3,526	4.7	3.7	3.2	3.2	3.1
Median age	39.9	38.2	35.2	35.8	37.0					
MEN										
Total, 16 years and over	48,933	54,343	62,590	66,017	68,907	67.9	63.3	61.5	61.3	61.2
16 to 24 years	8,101	11,773	13,520	12,458	11,305	11.2	13.7	13.3	11.6	10.0
25 to 54 years	31,962	33,279	39,282	43,761	48,160	44.3	38.7	38.6	40.6	42.8
55 years and over	8,870	9,291	9,788	9,798	9,442	12.3	10.8	9.6	9.1	8.4
Median age	39.7	38.2	35.2	35.8	36.9					
WOMEN										
Total, 16 years and over	23,171	31,560	39,219	41,699	43,669	32.1	36.7	38.5	38.7	38.8
16 to 24 years	4,619	8,143	10,261	9,726	9,014	6.4	9.5	10.1	9.0	8.0
25 to 54 years	14,634	18,208	22,662	25,441	28,261	20.3	21.2	22.3	23.6	25.1
55 years and over	3,918	5,209	6,296	6,532	6,394	5.4	6.1	6.2	6.1	5.7
Median age	40.3	38.2	35.1	35.9	37.1					

Chart # 2

TOTAL POPULATION, LABOR FORCE, AND PARTICIPATION RATES:

U.S. POPULATION, 1955-72, AND PROJECTED 1980-85.



from the 20 to 34 age group to the 35 to 54 age group, is an increase in the median age of the labor force from 35 in 1980 to 37.1 by 1990.[10] (See Table 5)

Graph 2 summarizes the data presented above. It shows the growth in the population of the U. S.--both historical and projected--as well as the growth in the labor force. The labor force participation rate is also shown and is almost constant over the entire period of study. This implies that the labor force grows at about the same rate as the growth in population, as verified by the two growth curves. Another factor that can be derived from Graph 1 is the anticipated decline in the growth rate of population and labor force. This is easily seen in the decreasing slope of the two curves after 1980.

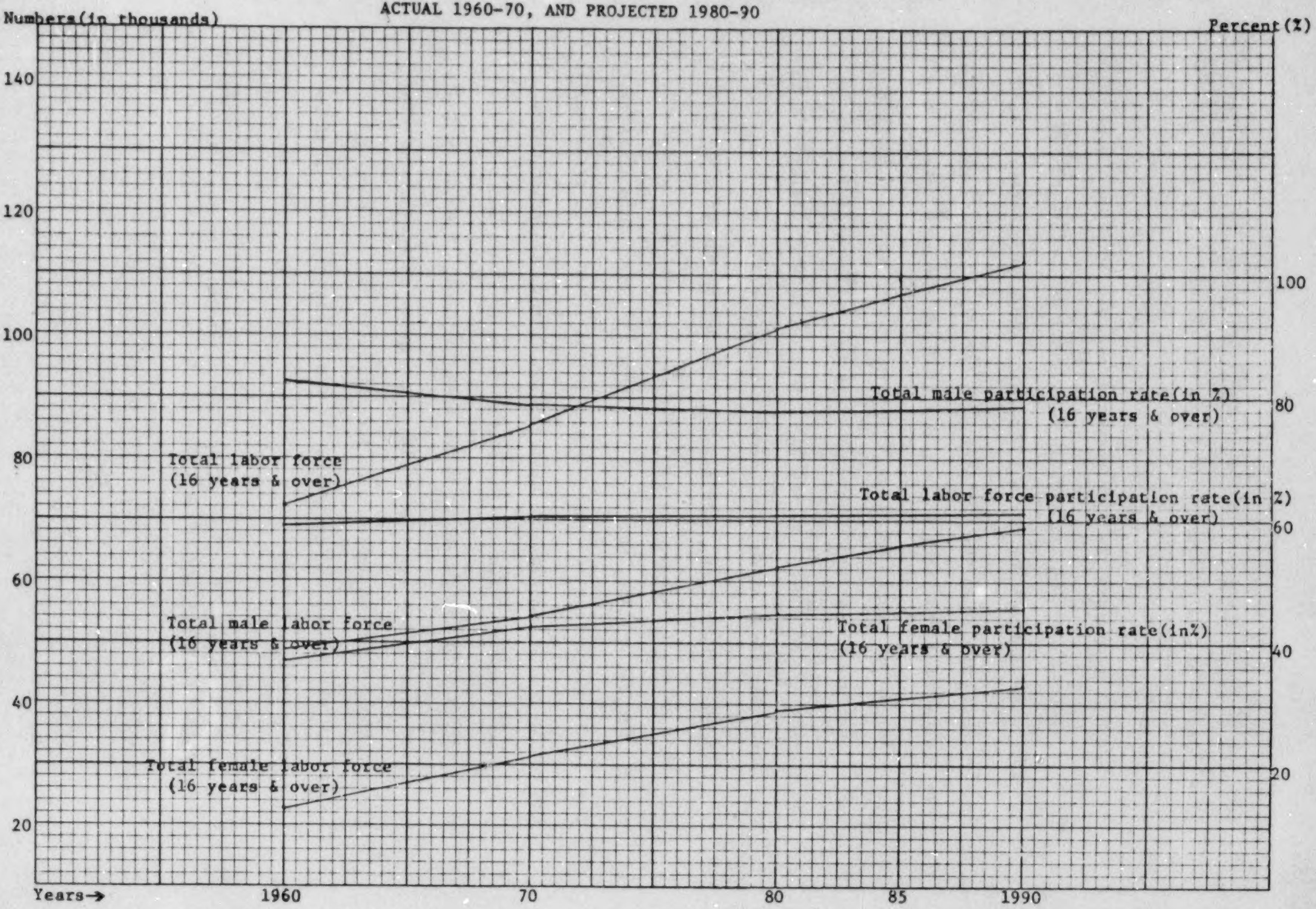
The labor force: sex composition. The percentage of women in the labor force is expected to rise from 32.4 percent during 1960-72, to 38.5 percent by 1980, and to 38.7 percent by 1985. This stabilization in the proportion of women workers in the labor force is primarily the result of the changing age distribution of the population. The projections show a decline in the number of young women and a very small increase in the number of women aged 45 to 64, as shown in Table 5. These are the two age groups with the highest participation rates among women. Also the decrease in the fertility rate of the U. S. population which occurred during the 1970's is expected to stabilize during the 1980's.[11]

---

[10] Denis F. Johnson. "The U. S. Labor Force, Projections to 1990," *Monthly Labor Review*, July 1973, pp. 3-13.

[11] *Ibid*., pp. 3-4

Chart# 3 TOTAL LABOR FORCE, AND LABOR FORCE PARTICIPATION RATES; ACTUAL 1960-70, AND PROJECTED 1980-90



Graph 3 represents the growth rate of the labor force, and distinguishes between the participation of males and females in the labor force. It can be seen from this graph that the male participation rate declined until 1970 and remained almost constant thereafter. But as we stated earlier, the female participation rate increases steadily through the 1970's and then slows down considerably after 1980.

The labor force: age composition. The two outstanding features in the projected growth of the labor force, as already mentioned, are the slow rate of growth--from an average annual rate of 1.7 percent in the 1970's to 1.0 percent during the 1980's--and the expected shift in the locus of major expansion, from the 25 to 34 age group to the 35 to 54 age group. The latter group, whose numbers are expected to increase by about 190,000 a year during the 1970's, is projected to grow an average of nearly 900,000 a year during the 1980's.

The teenage labor force, which increased from 5.2 million in 1960 to 7.7 million in 1970 is projected to increase still further but at a slower rate, reaching a peak in the late 1970's. Thereafter, this group is expected to decline slowly in numbers, reaching 7.2 million by 1985.

The group aged 45 to 54, which increased by 2.3 million between 1960 and 1970, is projected to decline by nearly 600,000 during the present decade, reaching 16.4 million by 1980. However, during the 1980's this trend is expected to reverse itself, and a gain of 180,000 a year, on average, is expected during the 1980's. Meanwhile, the number of people in the labor force aged 55-64 is expected to decline by nearly 50,000 a year, on average.

The outlook for workers 65 and over during the 1980's is for a slow but steady increase in number (20,000 a year), as the assumed decline in their participation rate is more than offset by the continued rise in their numbers--from 24 million in 1980 to 25.9 million in 1985.[12]

The labor force: occupation composition. Since World War II, the basic trend has been toward white-collar jobs. Between 1960 and 1968 employment of white-collar workers rose from about 28.5 million to 35.6 million, or 25 percent compared to a growth in total employment of 15 percent. Employment of service workers rose from 8.0 million to 9.4 million, or 17 percent, while employment of blue-collar workers increased only 14 percent.[13]

Throughout the 1970's, the rapid growth in requirements for white-collar workers is expected to continue. Faster than average growth is expected for service workers and slower than average for blue-collar workers. Farm workers will decline even further as a proportion of the labor force.

Generally, projections of employment reflect a continuation of employment shifts taking place during most of the past war period. Any changes tend to be in degree rather than direction. The big expansion in employment is expected to be in the services sector increasing its share to over 22 percent of total employment. Needs for workers in the service occupations are expected to increase nearly 40 percent during the 1970's; this is more than one and a half times the expansion rate of all occupations combined.

---

[12] Ibid., pp. 9-10

[13] Ronald E. Kutscher. "The U. S. Economy in 1985: Projections of GNP, Income, Output and Employment," Monthly Labor Review, Dec. 1973, pp. 27-42.

Employment requirements for service workers are projected at 12.7 million workers in 1980, compared with 10.9 million in 1972. The major factors contributing to these requirements are (1) a growing population, (2) expanding business, (3) increased leisure time, and (4) more disposable income. A somewhat slower rate of growth among service workers is projected for the period 1980-85 with total employment of service workers projected at 13.4 million by 1985. The rate of growth will fluctuate among the various service occupations. These figures are summarized in Table 6 and 7 on the following page.

The need for cooks and chefs is projected at 900,000 in 1980, a 3.3-percent increase over 1968. Waiters and waitresses will increase to 1.2 million, a 28-percent increase over 1968. The rapid increase in the population of groups that customarily patronize restaurants--workers, students, travelers, and increasing numbers of patients and hospital personnel--are factors in the growing requirements. Prepared foods and labor saving devices, as well as vending machines, will have some limited effect on the requirements for waiters, waitresses, and cooks.[14]

The personal nature of the services rendered by lodging establishments and the considerable number of smaller motels and other accommodations managed and operated with little paid help is reflected in the high concentration of managerial workers--more than one-fifth of the workers in the industry. In addition to a general manager in charge

---

[14] "Occupational,Manpower and Training Needs," Bulletin #1701, U. S. Department of Labor, Bureau of Labor Statistics.

Table 6

Employment by Major Occupational Group, 1960 and 1972, and Projected 1980 and 1985

[In thousands]

Occupational group	1960[1]	1972	1980	1985
Total	65,778	81,703	95,800	101,500
White-collar workers	28,351	39,092	49,400	53,700
Professional and technical workers	7,236	11,459	15,000	17,000
Managers and administrators	7,367	8,032	10,100	10,500
Sales workers	4,210	5,354	6,300	6,500
Clerical workers	9,538	14,247	17,900	19,700
Blue-collar workers	23,877	28,576	31,700	32,800
Craftsmen and kindred workers	8,748	10,810	12,200	13,000
Operatives[2]	11,380	13,549	15,000	15,300
Nonfarm laborers	3,749	4,217	4,500	4,500
Service workers	8,354	10,966	12,700	13,400
Private household workers	1,965	1,437	1,300	1,100
Other service workers	6,387	9,529	11,400	12,300
Farm workers	5,196	3,069	2,000	1,600

Table 7

Percent Distribution of Employment, by Major Occupational Group, 1960 and 1972, and Projected 1980 and 1985

Occupational group	1960[1]	1972	1980	1985
Total	100.0	100.0	100.0	100.0
White-collar workers	43.1	47.8	51.5	52.9
Professional and technical workers	11.0	14.0	15.7	16.8
Managers and administrators	11.2	9.8	10.5	10.3
Sales workers	6.4	6.6	6.6	6.4
Clerical workers	14.5	17.4	18.7	19.4
Blue-collar workers	36.3	35.0	33.1	32.3
Craftsmen and kindred workers	13.3	13.2	12.8	12.8
Operatives[2]	17.3	16.6	15.6	15.1
Nonfarm laborers	5.7	5.2	4.7	4.4
Service workers	12.7	13.4	13.3	13.2
Private household workers	3.0	1.8	1.3	1.1
Other service workers	9.7	11.6	12.0	12.1
Farm workers	7.9	3.8	2.1	1.6

of over all operations most larger hotels employ management specialists in such areas as food service, sales, credit, purchasing, and clerical operations. About 4 out of 5 workers in this industry perform service or managerial functions that may be aided, but not substituted for, by machines. Accordingly, technological change is not expected to have a significant impact on the industry's occupational structure.

We enter a caveat here, however: As we said earlier, these prognostications depend upon a society moving forward in a pattern suggested by the recent past. Unforeseen social, politcal, economical, or physical developments could alter their reliability.

The labor force--productivity. Over the 15-year period beginning in 1955, the average rate of increase in productivity was 3.0 percent per year. This rate is expected to decline to 2.9 percent over the 1970-80 period, and to 2.8 percent per year between 1980 and 85. Productivity changes in trade services and in construction over the projected period reflect an increase over their historical rates, while productivity in the service sector and in finance, insurance, and real estate are expected to decline somewhat.[15]

Relative growth in productivity among sectors is also an important element in employment shifts within the economy. The rising demand in service industries coupled with below average increases in productivity are expected to cause employment demands in this sector to increase greatly.

The shifts in employment projected for major sectors are more

---

[15] Kutscher, *op. cit.*, p. 37.

Table 8

Productivity Change by Sector, Average Rate During Selected Periods 1948-72 and Projected to 1980 and 1985

Sector	Average annual growth rate [1]						
	Actual			Projected			
	1948–68 [2]	1955–68	1968–72	1968–85	1968–80	1972–80	1980–85
Total private	3.2	3.0	2.3	2.8	2.9	3.2	2.8
Agriculture	5.8	5.5	4.5	5.5	5.5	6.1	5.5
Nonagriculture	2.7	2.6	2.2	2.7	2.7	3.0	2.7
Mining	4.0	3.6	1.0	.9	.9	.9	.8
Contract construction	[3]	[3]	[3]	.8	.8	1.5	.7
Manufacturing	2.9	2.7	3.8	2.9	3.1	2.7	2.6
Durable	[3]	2.4	3.3	2.9	3.2	3.1	2.4
Nondurable	[3]	3.2	4.7	2.9	2.9	2.0	2.8
Transportation, communication, and public utilities	[3]	4.5	3.9	4.3	4.4	4.6	4.0
Transportation	3.2	3.5	2.4	3.4	3.6	4.1	3.1
Communication	5.6	5.9	5.0	5.3	5.4	5.6	4.9
Public utilities	5.8	5.1	3.5	4.3	4.3	4.7	4.3
Trade	2.8	2.9	1.9	2.7	2.7	3.1	2.5
Wholesale	[3]	3.5	1.8	2.5	2.7	3.2	2.1
Retail	[3]	2.5	1.9	2.6	2.6	3.0	2.6
Finance, insurance, and real estate	[3]	[3]	[3]	1.6	1.4	2.8	1.9
Other services	[3]	[3]	[3]	2.5	2.5	3.6	2.4
Government enterprises	[3]	[3]	[3]	2.8	2.7	2.6	2.9

[1] Compound interest between terminal years.

[2] Least squares growth rates.

[3] Not available.

NOTE: Productivity data are GNP per man-hour with the GNP stated in constant 1972 prices.

pronounced than the changes in the distribution of output because of the differing degrees of changes in productivity. For example, services output will show only a modest increase as a proportion of total output, but there will be a pronounced increase in services employment as a share of total employment.

The low productivity in the service industries stems mainly from the fact that the personal nature of the services provided requires a large proportion of supervisors and trained personnel and does not lend itself readily to most methods of mechanization.[16]

The relative changes in productivity among the various sectors of the economy are shown in Table 8. Notice that over the periods for which data is available, productivity gains in the services sector (stated as "other services" on the table) is consistently below the average growth in productivity for all sectors combined ("Total private" on table). Growth in productivity in all of the services (finance, insurance and real estate as well as "other services") is also consistently less than for each of the other sectors of the economy except for mining and construction. These last two sectors have been declining in importance since the past war period when their major growth in productivity occurred.

Population. Labor force expectations are based on expected changes in the population. Between 1972 and 1980, the U. S. population is projected to increase by about 15 million to 224 million. However, if the current rate of child birth continues, the size of the population under

---

[16] Tomorrow's Manpower Needs, National Trends, and Outlook, Bulletin #1606, U. S. Department of Labor, Bureau of Labor Statistics.

16 years old will decline by over 4 million while the working-age population (16 years and over) will rise by 19 million. As we mentioned earlier, the greatest increase in the population will be in the 20 to 34 year age group. The net effect of these changes will be to increase the proportion of the population that is of working age from 71 percent in 1972 to 75 percent in 1980.

Between 1980 and 1985 the population under 16 years of age is projected to increase by 32 million, reflecting the continuing rise in the number of women of child-bearing age. While the 20 to 34 year old group continues to increase by about 3 million, the greatest increase in population during this 5-year period will be in the 35 to 54 year age group, which is expected to increase by 5.4 million. The long-run trend, then, is for a continued increase in the average age of the U.S. population due to the reduction in the birth rate. The median age of the U. S. population was 28.1 years in 1972, it is expected to increase to 29.6 years in 1980, and to 30.6 years by 1985.

The fertility decline of the past 15 years implies a dramatic shift from a "three child" to a "two child" family norm. This shift has been associated with changes in the role of adult women, particularly with respect to their interest in, and availability for, paid employment. The projection for the U. S. population to 1985 assumes that the "two child" norm shall continue to prevail. Since current fertility rates are already consistent with the level needed to sustain that norm, no further decline in the fertility rate is expected. This stabilization of the fertility rate, as mentioned above, is largely responsible for the leveling off of the women in the labor force.[17]

Gross National Product. Gross National Product is projected to increase slightly faster from 1968 to 1980 than it did during the previous 15 years, but then it will slow down considerably from 1980 to 1985. This increase and the later sharp slow down in the rate of economic growth reflects changes in the pace of labor force growth. By contrast, productivity or output per man hours in the total private economy is expected to drift down slowly during the 1968-85 period.[18]

Growth in Percent	1955-68	1968-80	1980-85
GNP (1972 dollars)	3.7%	4.0%	3.2%
Personal income (current dollars)	6.3	8.0	6.5
Private GNP per man hour (1972 dollars)	3.0	2.9	2.8
Employment (count of jobs)	1.6	1.9	1.2

Economic growth depends on the size of the labor force, employment, and hours of work, and productivity. When resources are fully utilized, changes in historical and projected growth rates come about largely because of changes in the rate of increase in the labor force (assuming no sharp departure from the long-term trend in productivity and hours worked.) The determination of the slow-down in economic growth expected between 1980 and 1985 is associated with a sharply lower annual rate of increase in the labor force, which itself was caused by a slow annual rate of increase in the population.

Per capita income and consumption. A particularly important facet of the projections presented in this report is the growth in real per capita income. The 1968-80 projected growth calls for an appreciably faster rate of increase over this period compared to the 1955-68 rate. This general indicator of the standard of living gives a favorable outlook for the rest of the 1970's, with the early 1980's returning to a rate of increase more like that of the late 1950's and 1960's.[19]

---

[17] Johnson, op. cit., pp. 8-9.

[18] Kutscher, op. cit., p. 27.

Table 9 represents a summary of historical and projected personal income, personal disposable income, and personal consumption. Personal income is shown to grow at a fairly rapid rate, especially over the 1968-80 period. Its growth rate after 1980 is considerably slower, reflecting the expected slow down in the rate of growth in GNP and employment. Disposable income, over this same period, shows a somewhat slower rate of growth, reflecting both the increased proportion of income being spent on interest and taxes, and also the increased rate of inflation.

The 1980-85 slowdown in employment growth does not present any great difficulty for persons in the labor force, because it results from fewer entrants into the labor force. One could even envision a more orderly adjustment in the labor force as the economy moves toward absorbing only 1.2 million new entrants into the labor force in the 1980's, compared with 2.3 million in the 1970's.

Personal income goes for consumption, savings, interest, and taxes. In the 1968-80 period, differences between growth in personal income and personal taxes will be small because of tax reductions and a slowing in the rate of growth in state and local tax collections. However,

---

[19] Kutscher, op. cit., p. 30.

Table 9

Personal Income: Sources and Disposition, Selected Years 1955-72 and Projected to 1980 and 1985

[Billions of current dollars]

Component	Actual				Projected		Average annual rate of change[1]					
	1955	1960	1968	1972	1980	1985	1955–68	1968–72	1968–85	1968–80	1972–80	1980–85
Personal income; sources	$310.9	$401.0	$688.9	$939.2	$1,736.5	$2,376.9	6.3	8.1	7.6	8.0	8.0	6.5
Compensation of employees[2]	218.6	282.8	490.3	663.6	1,195.7	1,655.9	6.4	8.1	7.4	7.8	7.6	6.7
Government transfers to persons	16.1	26.6	56.1	93.3	178.4	227.6	10.1	15.1	8.6	10.1	7.7	5.0
Other sources[3]	87.3	112.3	189.6	245.0	484.6	650.1	6.1	6.7	7.5	8.2	8.9	6.0
Less total contributions for social insurance	11.1	20.7	47.1	73.7	129.3	164.1	11.8	12.6	7.6	8.8	7.2	4.9
Personal income: disposition	310.9	401.0	688.9	939.2	1,736.5	2,376.9	6.3	8.1	7.6	8.0	8.0	6.5
Personal tax and nontax payments	35.5	50.9	97.9	142.2	269.3	337.0	8.1	9.8	8.6	8.8	8.3	8.1
Personal outlays	259.5	333.0	551.2	747.2	1,365.9	1,845.6	6.0	7.9	7.4	7.9	7.8	6.2
Personal consumption expenditures	254.4	325.2	536.2	726.5	1,321.2	1,783.2	5.9	7.9	7.3	7.8	7.8	6.2
Interest paid by consumers	4.7	7.3	14.3	19.7	43.9	61.6	8.9	8.3	9.0	9.8	10.5	7.0
Personal transfers to foreigners	.5	.5	.8	1.0	.8	.8	3.7	5.7	....	....	−2.8	....
Personal savings	15.8	17.0	39.8	49.7	101.3	134.3	7.4	5.7	7.4	8.1	9.3	5.8
Other items:												
Disposable personal income (DPI)	275.3	350.0	591.0	797.0	1,467.2	1,979.8	6.1	7.8	7.4	7.9	7.9	6.2
Saving rate (as percent of DPI)	5.7	4.9	6.7	6.2	6.9	6.8	1.3	−1.9	−.1	−.3	1.4	.3
DPI per capita (current dollars)	1,659.1	1,937.3	2,944.6	3,816.4	6,545.5	8,399.6	4.5	6.7	6.4	6.9	7.0	5.1
DPI per capita (constant 1972 dollars)	2,477.6	2,610.5	3,432.8	3,816.4	5,113.0	5,719.4	2.5	2.7	3.0	3.3	3.7	2.3

[1] Compound interest rates between terminal years.

[2] Covers wage and salary income and other labor income.

[3] Covers proprietors, income, rental income of persons, dividends, and personal interest income.

because of the progressive nature of the income tax system and the growth in social insurance contributions, taxes will continue to take on an increasing share of income over the 1980-85 period. Savings, on the other hand, has had and is projected to continue to have a rather constant share of income. At the same time, interest has shown a modest increase in its share of income both historically and in the projected period. The result of the increase in the proportion of income going to taxes and interest, and a fixed share to saving, is for personal consumption to represent a declining share of income.[20]

	1955	1968	1972	1980	1985
Personal Income	100.0%	100.0%	100.0%	100.0%	100.0%
Taxes (personal and social insurance)	11.4	14.2	15.1	15.5	16.7
Savings	5.1	5.8	5.3	5.3	5.3
Other (interest and foreign transfers)	1.7	2.2	2.3	3.0	3.0
Personal consumption expenditures	81.8	77.8	77.4	76.2	75.0

Disposable income per capita is used as a crude measure of the standard of living. It is projected to increase from $1689 in 1955 to $3816 in 1970, $6546 in 1980, and $8400 by 1985. In constant 1972 dollars the change is from $3816 in 1972 to $5719 in 1985, or a 3.1 percent a year increase. However, this expansion--as is true with other elements of the projections--has an uneven pattern of growth within the projection period.

---

[20] Ibid., p. 31.

Personal consumption expenditures (PCE) is by far the largest component of fixed demand, about two-thirds of total GNP. The projected 1980 level of PCE is $751.9 billion, with a projected rate of increase of 4.3 percent a year. Both figures are for an economy with an average 4-percent rate of unemployment. This is a somewhat faster rate of growth than occurred during the entire post-war period, but it is closer to the 4.1-percent rate experienced between 1957 and 1966.

The projected expansion of consumer expenditures is in keeping with the long-run trend of expansion rates slightly faster than growth in GNP. The three major components of personal consumption expenditures--durables, non-durables, and services--each show the same pattern of strong growth during 1968-80, and somewhat slower growth during 1980-85. However, the relative amount of slowing varies among the three components.[21]

	Rate of Growth in 1972 Dollars			
	1955-68	1968-80	1972-80	1980-85
Total	3.9%	4.3%	4.5%	3.3%
Durables	5.0%	5.1%	4.4%	3.1%
Non-durables	3.1%	3.6%	3.9%	2.8%
Services	4.4%	4.6%	5.0%	3.8%

Some implications. As we stated earlier, the projections given in this report are based on a full employment economy with 4-percent inflation. With these assumptions in force, we have attempted to show the rate of growth in the labor force, in employment, in GNP, and in personal income. Our results show that a slowdown in economic growth is expected in the mid 1980 s caused primarily by a dramatic decline in the rate of growth of the U. S. population. This decline in growth of the population is also the main contributor to the increasing average age of the population and work force.

---

[21] Ibid., pp. 31-33.

Other projections presented here show a slight decrease in productivity improvements over the projected period and an increasing demand in the transportation, public utilities, financial, and service sectors of the economy. This increase in demand accompanied by lower rates of growth in productivity is expected to create a fairly sharp increase in demand for workers in the services sector.

Finally, per capita personal income is expected to increase at a faster rate than in the past, adding to the increase in demand in all sectors of the economy.

Employment requirements are affected by such factors as a growing population, expanding business, increased leisure time, and increased disposable personal income. But these factors are, in turn, affected by the general overall condition of the economy. While the demographic characteristics of the U. S. population and labor force presented in this paper will not be much affected by changes in the economy, the other projections presented here may be drastically affected. An increase in the rate of inflation or in the rate of unemployment will obviously change the projected levels of disposable income and personal consumption. In light of the recent fuel shortages, production cutbacks, and increases in inflation and unemployment, the projections presented in this report may be subject to question. However, we recognize that the projections stated here are for the long run, while the phenomena just stated are expected to be short run in nature.

Bibliography

1. Jack Alterhan. "The U. S. Economy in 1985: An Overview of BLS Projections." Monthly Labor Review, U. S. Dept. of Labor, Bureau of Labor Statistics (December, 1973), p. 3.

2. Denis F. Johnson. "The U. S. Economy in 1985: Population and Labor Force Projections." Ibid., p. 8.

3. Neal H. Rosenthal. "The U. S. Economy in 1985: Projected Changes in Occupations." Ibid., p. 18.

4. Ronald E. Kutscher, "The U. S. Economy in 1985: Projections of GNP, Income, Output, and Employment," Ibid., p. 27.

5. Denis F. Johnson. "The U. S. Labor Force: Projections to 1990," Monthly Labor Review, U. S. Dept. of Labor, Bureau of Labor Statistics (July, 1973), p. 3.

6. Charles M. O'Conner. "Wages and Tips in Restaurants and Hotels." Monthly Labor Review, Vol. 94, Number 7, (July, 1971), p. 47.

7. Anonymous. "Occupational, Manpower and Training Needs." U. S. Dept. of Labor, Bulletin #1701. Bureau of Labor Statistics.

8. Anonymous. "Tomorrow's Manpower Needs, National Trends and Outlook: Industry Employment and Occupational Structure." U. S. Sept. of Labor, Bulletin #1606, Bureau of Labor Statistics (February, 1969).

9. Anonymous. "Tomorrow's Manpower Needs, National Trends and Outlook: Industry Employment and Occupational Structure." U. S. Dept. of Labor, Bulletin #1606, (February, 1969).

10. Anonymous. "Patterns of U. S. Economic Growth: 1980 Projections of Final Demand, Interindustry Relationships, Output, Productivity and Employment." U. S. Dept. of Labor, Bureau of Labor Statistics, Bulletin #1672 (October, 1970).

11. Robert E. Graham, Jr., Henry L. DeGraff, and Edward A. Tratt, Jr. "State Projections of Income, Employment and Population." Survey of Current Business (April, 1972).

12. Anonymous. "The Structure of Food Manufacturiing--A Report by the Staff of the Federal Trade Commission," Technical Study #8, National Commission on Food Marketing (June, 1966).

13. Anonymous. "Industry Wage Study: Candy and other Confectionary Products." U. S. Dept. of Labor, Bureau of Labor Statistics, Bulletin #1732 (August, 1970).

14. Anonymous. "Industry Wage Study: Eating and Drinking Places, October, 1966, and April, 1972." U. S. Dept. of Labor, Bureau of Labor Statistics, Bulletin #1585 (April, 1968).

15. Anonymous. "Industry Wage Study: Hotels and Motels, October, 1966, and April, 1967." U. S. Dept. of Labor, Bureau of Labor Statistics, Bulletin #1587 (April, 1968).

16. Anonymous. "Occupational Outlook Handbook." U. S. Dept. of Labor, Bureau of Labor Statistics, Bulletin #1550.

17. Anonymous. "Employees Earnings and Hours in Retail Food Stores," U. S. Dept. of Labor, Bureau of Labor Statistics, Bulletin #1584-3 (June, 1966).

18. Anonymous. "Wages and Tips in Restaurants and Hotels; March, 1970," U. S. Dept. of Labor, Bureau of Labor Statistics, Bulletin #1712 (March, 1971).

19. Edward F. Denison. "The Shift to Services and the Rate of Productivity Change." Survey of Current Business, U. S. Dept. of Commerce, Volume 53, Number 10 (October, 1973), p. 20.

20. Robert B. Bertzbelder. "Geographic Trends in Personal Income in the 1960's." Survey of Current Business, U. S. Dept. of Commerce, Volume 50, Number 8 (August, 1970), p. 14.

21. Anonymous. "Organization and Competition in Food Retailing." National Commission on Food Marketing, Study #7 (June, 1966).

Conclusion to the Economics Section
# of the
Food Services Futures Report

Predicting is an inherently difficult activity; moreover, projections of occupational requirements must always be placed in the proper perspective. We want, therefore, to mention in this Conclusion several caveats to our study. First, predictions are only as good as their underlying assumptions; a slight error in such an elementary area as data accumulation can skew any prediction made on the basis of that data. In addition, the further into the future one looks, the more magnified an error of, say, a mis-specified variable or a faulty assumption can become.

Second, the relative importance of particular occupations tends to change in response to technological change, changes in production scale, changes in production mix, and changes in the organization of industry.

Third, the level of employment in an industry is correlated to the output of that industry. Output is highly sensitive to changes in the business cycle as well as to attitude changes in the highly unpredictable American consumer.

And fourth, predictive accuracy is constrained by statistical imperfections in sampling and testing. Census taking and statistical sampling have become highly honed sciences, but they are not yet infallible. Inasmuch as projections are self-fulfilling prophecies (that is, provide some direction for long-range planning), they have a recognized place in the scheme of things. But numerous forces--all, by definition, within the realm of the unexpected--that can conspire to undermine the reliability of statistical projections are always at hand.

A Bibliography of the Economics of Food Consumption

Preface

This bibliography represents an attempt to organize a moderately comprehensive set of references on the economics of food consumption. The publications listed reflect a particular relevance to home and away-from-home food consumption. The goal was to provide an initial survey of background information concerning factors that affect patronage of food operations of the hospitality industry, restaurants, hotels, and motels.

The reader may want to supplement this bibliography with Consumer Behavior: An Annotated Bibliography with Special Emphasis on Food by Bylund, Hostettler, and Tomlinson, referred to hereafter as simply Bylund, and listed under the subheading "Bibliographical Sources." It presents a comprehensive view of the literature from 1955 through 1959. Some articles listed in Bylund appear, with an appropriate additional reference, in the present work.

This bibliography has been organized to make information available to those particularly interested in hospitality industry food service. Accordingly, the work has been partially annotated and grouped under six major divisions: "Methodology and Bibliographical Sources"; "Aggregate Demand for Food"; "Interrelationships of Supply and Demand Affecting the Level of Demand"; "Away-From-Home Food Market"; "Consumer Behavior"; and "Poverty and Food Consumption." A list of journal abbreviations appears at the end.

I. Methodology and Bibliographical Sources

A. Methodology

1. Survey Methodology

M. C. Burk and T. J. Lanahan. "Use of 1955 Food Survey Data for Research in Agriculutral Economics." Ag. Econ. Research, 10, No. 3 (July, 1958), pp. 79-98. See Bylund, pp. 7-8.

M. B. Carroll. "Screening in the Food Industry," JASA, Vol. 52 (279), (1959), p. 365. See Bylund, p. 22.

F. Clark. "USDA Household Food Consumption Surveys and their Uses." JEBH (1967), pp. 177-84.

P. J. Francois. "Food Consumption Surveys--Study on a General Formula for Estimation of Per Capita, Household and Group Consumption," FNNL, Vol. 8, No. 4 (October-December, 1970), pp. 10-26.

D. B. Levine and H. P. Miller. "Response Variation Encountered with Different Questionnaire Forms," Marketing Research Report 163, USDA AMA (April, 1957). See Bylund, p. 7.

P. G. Miller, J. H. Nair and A. J. Harrinan. "A Household and a Laboratory Type of Panel for Testing Consumer Preference." FT, Vol. 9, No. 9 (September, 1955), pp. 445-449. See Bylund, p. 26.

2. Mathematical or Statistical Methods

Ragnar Frisch. "A Complete Scheme for Computing all Direct and Cross Demand Elasticities in a Model with Many Sectors," Econometrica, Vol. 27, No. 2 (1959), pp. 177-96.

Gordon A. King. "An Appraisal of the Strengths and Weaknesses of the Econometric Approach," AJAE, Vol. 45 (December. 1963), pp. 1408-1419.

This paper focuses on development in the formulation of econometric models for use in understanding and predicting consumer demand for food.

J. A. Nordin; G. G. Judge, and O. Wahby. "Application of Econometric Procedures to the Demands for Agricultural Products," *Iowa Agr. Expt. Sta. Res. Bul*. 410 (1954).

H. Wold and L. Jureen. *Demand Analysis, A Study in Econometrics* (New York: Wiley and Sons, 1953).

3. Miscellaneous Methodology

H. E. Allison; C. J. Zwick; and A. Brinser. "Menu Data and their Contribution to Food Consumption Studies," *AJAE*, Vol. 40, No. 1, (February, 1958), pp. 1-20. See *Bylund*, pp. 56-57.

M. C. Burk. "Measures and Procedures for Analysis of U.S. Food Consumption," *USDA, Agr. Handbook 204* (1958), 123 pp.

M. C. Burk. "Studies of the Consumption of Food and Their Uses," *AJAE*, Vol. 38, No. 5 (December, 1956), pp. 1736-1746.

M. C. Burk. "The Study of Regional Food Consumption," *AJAE*, Vol. 41 (December, 1959), pp. 1040-49.

A. F. Carlin; O. Kempthorne and J. Gordon. "Some Aspects of Numerical Scoring in Subjective Evaluations of Foods," *Food Research*, Vol. 21, No. 3, (May-June 1956), pp. 273-281. See *Bylund*, p. 38.

M. B. Carroll. "Screening in the Food Industry," ABS *JASA*, Vol. 52, No. 279 (1957) p. 365. See *Bylund*, p. 22.

J. Eindhoven and D. R. Peryam. "Measurement of Preferences for Food Combination," *FT*, Vol. 13, No. 7 (July, 1959), pp. 379-382. See *Bylund*, p. 63.

M. J. Farrell. "The New Theories of the Consumption Function," *Economic J*., Vol. 69 (1959).

M. Friedman. *A Theory of the Consumption Function* (Princeton: University Press, 1957).

H. L. Hanson; J. G. Davis; A. A. Campbell; J. H. Anderson; and H. Lineweaver. "Sensory Test Methods, II: Effect of Previous Tests on Consumer Response to Foods," *FT*, Vol. 9, No. 2 (February, 1955), pp. 56-59. See *Bylund*, p. 43.

M. G. Reid. "What We Do and Do Not Know About Food Consumption of American Families," AJAE, Vol. 40, No. 5, (December, 1958), pp. 1301-1311. See Bylund, p. 175.

V. J. Rhodes. "The Measurement of Consumer Preferences," AJAE, Vol. 37, No. 4 (November, 1955), pp. 638-651. See Bylund, p. 144.

D. Sheppard. "Descriptive Terms and Points Systems for Rating Food Qualities," Food Research, Vol. 20, No. 2 (January-December, 1955), pp. 115-117. See Bylund, p. 24.

USDA, "Schedule Used in the Survey of Food Consumption of Households in the United States, Spring, 1955." Agricultural Marketing Series: AMS-200 (July, 1957). See Bylund, pp. 9-10.

B. Bibliographical Sources

Bibliography of Agriculture, National Agricultural Library, U.S. Dept. of Agriculture.

The Bibliography of Agriculture is a monthly index to the literature of agriculture and allied sciences, based upon records prepared by U.S. Nat'l. Ag. Library. Articles of substantial interest are selected by specialists. About 120,000 articles are cataloged each year.

"Bibliography of Food Service Market Studies and Related Source Materials." Institute for Food Service Manufacturers Assoc., (Chicago: 1969), 10 pp.

H. B. Bylund; R. S. Hostetter; and W. L. Tomlinson. Consumer Behavior, (An annotated bibliography with special emphasis on food.) The Pennsylvania State University Dept. of Ag. Econ. (University Park, 1962), 220 pp.

This bibliography is a comprehensive set of references and a review of writings pertaining to consumer behavior as related to food prescribed in a way meaningful to the user. Topics covered with respect to consumer behavior and food consumption are methodology, advertising, cognitive and affective factors, consumer choice (acceptance and preference), and marketing research and consmption. The major drawback of this bibliography is that it is highly dated.

Cumulative Index 1973. (New York: The Conference Board Inc., 1973).

The Conference Board is an independent, non-profit business research organization. Its purpose is to promote prosperity and security by assisting in the effective operation and development of voluntary productive enterprise. The index to the Conference Board's published research material is revised annually with special emphasis on the past 10 years of research.

The Demand and Price Situation, National Economic Analysis Division, Economic Research Service, USDA.

The Demand and Price Situation is a quarterly publication designed to analyze the economic situation of the nation and determine how fluctuations in economic activity will affect agricultural production and prices and how agricultural prices affect consumption. Other publications of a similar nature but much more specific are the following: Fats and Oils Situation, The Feed Situation, The Vegetable Situation, The Wheat Situation, Livestock Slaughter and Meat Production, Poultry and Egg Situation.

Dictionary Catalog of the Giannini Foundation of Agricultural Economics Library, Vol. 12, University of California Berkeley (Boston: G. K. Hall, 1971).

The catalogs provide extended bibliographics of all aspects of agricultural economics. Most of the materials in the library date from 1920 to the present. Topics included of interest to food consumption analysis are consumer's preference, consumption, marketing, and retailing of agriculturally derived products.

C. L. Gregory. A Bibliography for the Sociological Aspects of Consumer Demands for Food Products, Univ. of Missouri, no date.

Selected Research Abstracts of Published and Unpublished Reports Pertaining to the Food Service Industry, Including Recommendations for Research Needs, USDA ARS (Washington: GPO, 1970).

Katherine Spinney. "A Bibliography: Hotel and Restaurant Administration and Related Subjects, CHRAQ, Vol. 11, No. 2. (August, 1970), pp. 51-105.

The bibliography, which is produced annually, lists articles appearing in the previous year's trade journals dealing with almost every aspect of hospitality management.

II. Aggregate Demand for Food

A. Data

Faith Clark; J. Murray; G. S. Weiss; and E. Grossman. Food Consumption of Urban Families in the United States with an Appraisal of Methods and Analysis, USDA, Ag. Info. Bulletin 132 (1955), 203 pp.

This bulletin presents the results of surveys made in 1948-49 in which approximately 4500 schedules were finished by households on their food consumption for a week. Also included is a comparison with a 1942 survey. An average urban family of 3.29 persons spent $26/week for food, about $8 per person. Food eaten away from home accounted for $4 of the average $26 spent for food.

Household Food Consumption Survey 1955, 17 Volumes, USDA, December 1956. Household Food Consumption Survey 1965-1966, Consumer Food Economics Research Division, ARS USDA.

The HFCS is a detailed study of how family income affects the consumption of food commodities. For each income level there is data for the quantity of a commodity which is used per household per week; in pounds, money value per household per week spent on commodities, and the percentage of households using the commodity in a week. There are 17 volumes to the final report each about 200 pages, detailing regional, seasonal, nutritional and other aspects of household food consumption by income level.

Survey of Consumer Expenditures 1960-61 Data, USDL, Bureau of Labor Statistics 1965.

The SCE is a nationwide survey of expenditures and income of families living in urban and rural areas. The final reports present data combined into four geographic regions and the total United States and also for urban, rural non farm, and rural farm populations. The final reports have three groups of tables: U.S. and regional summaries, cross-classifications of family characteristics, and details of expenditures and income. The way the reports are organized make it possible to determine independently of each other the effect of income and family size on the share of income spent for food. As income increases, the share of income spent for food declines. As family size increases, the share spent for food increases.

Fabian Linden, ed. Expenditure Patterns of the American Family, The National Industrial Conference Board, 1965 (sponsored by Life).

A statistical summary of expenditure patterns of the American family is depicted based on data from the 1960-61 Survey of Consumer Expenditures.

S. J. Heimstra. Food: Consumption, Prices, and Expenditures, Agricultural Economic Report, No. 138 USDA, ERS (July, 1968), 193 pp.

During the last half century, per capita food consumption and food use have gradually increased. The number of pounds of food consumed per capita have increased and calories consumed per capita have decreased. Retail food prices and the total consumer price index have more than tripled, but since 1950 food prices have not risen as much as the total CPI. Prices of food away from home follow the level of prices for all services and have increased much faster than prices for food at home. Changes in demand for food are related to population growth, price changes among commodity groups, shifts in consumer tastes, and changes in income. There are over 140 pp. of statistics to support the analysis of changes in the demand for food. A recent supplement updates most of the tables to include 1966-1972.

B. Aspects of Demand

Sadye F. Adelson. Changing Food Patterns in the United States, USDA ARS (1967), 14 pp.

Marguerite C. Burk. "Changing Food Patterns of the American People," NFS 73, August, 1955, pp. 13-22.

M. C. Burk. Consumption Economics, A Multidisciplinary Approach. (New York: Wiley, 1968), 359 pp.

The approach to this book was influenced by the author's experience as an agricultural economist with the USDA, where she frequently wrote on the economics of food consumption. This book presents her approach to consumption economics with much of the analysis drawn from her experience with food consumption analysis. Discussed are micro and macro approaches to consumption and a guide for analyzing consumption problems. Also there is a bibliography on consumption economics.

M. C. Burk. Consumption of Processed Farm Foods in the United States, USDA, Mktg. Res. Report 409 (1960), 47 pp.

M. C. Burk. Trends and Patterns in U.S. Food Consumption, USDA Agr. Handbook 214 (1958), 123 pp.

Two aspects of food consumption are treated in this bulletin. They are the broad outline of trends in the U.S. food supplies and consumption through the past 50 years; and, some significant patterns of cross-sectional variations within the country in selected periods of the half century studies per capita use of farm foods from all sources was 13 percent higher in 1955-59 than 30 years earlier. The shift from home produced foods to purchased foods was an important factor in the 59 percent increase in average use of food marketing services from 1935-39, to 1955-59. Income elasticities of per person expenditure for all food declined from 1942 to spring 1955. Thus expenditures varied less with income of households in the more recent (1955) than the earlier period (1942). From 1947 to 1955 the proportion of disposable income spent for food decreased each year except 1951.

Helen M. Eklund. "A Cross Sectional View of U.S. Food Consumption" NFS 128 (May, 1969), pp. 24-49.

This report presents price weighted cross-sectional food consumption indexes developed from information collected in the spring 1965, Household Food Consumption Survey, in order to evaluate patterns of food consumption on a consistent basis. Family income and urbanization are the relevant variables. Per capita consumption indexes by level of family income, showing changes in food consumption as income changes, are given for different urbanizations. Regional statistics by income and urbanization were also given. Results: (1) Regional variations in per capita food consumption were cut in half 1955 to 1965, (2) in 1955 and 1965, a 10 percent increase in per capita income was associated with a 1.5 percent increase in per capita food consumption, (3) the Northeast had the highest and South the lowest per capita food consumption (4) regional income shifts explain part of the shifts in consumption, and (5) a 10 percent increase in income led to the following responses: 3 percent increase for beef, processed fruits, vegetables, and potatoes; 0 percent pork, chicken, fish, fresh potatoes and coffee showed little association with income; consumption of cereal products and eggs declined slightly as incomes increased.

John E. Erstman. "U.S. Consumption of Frozen Foods." JM 27, No. 3 (July, 1963), p. 76.

"Food Expenditure Outlook," NFS Vol. 118 (November, 1966), pp. 26-32.

Food expenditures in the third quarter of 1966 were nearly 8 percent above the 1965 level, the largest annual increase since 1951 to that date. Most of the increase in food expenditures was due to 4.5 to 5.0 percent increase in prices. Population and per capita food consumption each increased about 1 percent. Per capita disposable income was about 7 percent higher in 1966 than 1965 and 18.2 percent of income was spent for food. Sales of grocery stores increased 6 percent, eating places 12 percent, and drinking places 3 percent. A

brief analysis of the 1965 Household Food Consumption Survey shows the value of food per capita for one week in spring 1965 was $10.65 with $1.86 spent for food away from home. Spring is the most representative for eating patterns of the four seasons.

Karl Fox. "Relations Between Prices, Consumption and Production." JASA, Vol. 56, No. 255 (September, 1951), pp. 323-333.

Hazen F. Gale. "Food in the 1960's. Expenditures, Prices, and Consumption." NFS, 133 (August, 1970), pp. 25-28.

During the 1960's the proportion of income spent for food declined from 20.0 percent to 16.7 percent. Food prices rose 24.0 percent, and per capita consumption rose 5.5 percent. Food expenditures per person increased due to increase in prices and consumption. The increase in prices and consumption was much larger after 1965, than before 1965.

Frederick D. Gray. "Population and Food Consumption," NFS, 123 (February, 1968), pp. 24-26.

Population is the primary determinant of demand for agricultural products in a high income country such as the U.S. Although per capita consumption in pounds has decreased, the price weighted food consumption index has increased showing that people are buying higher priced foods (meats) and more highly processed foods. If per capita food consumption remains relatively constant, the food industry will grow in proportion to the population.

A Guide to Consumer Markets, 1972-73, Conference Board Report 569.

D. B. Hacker and E. D. Miller. "Food Patterns of the Southwest." The American J. of Clinical Nutrition, Vol. 7, No. 3 (March-April, 1959), pp. 224-229.

S. J. Heimstra and H. M. Eklund. "Food Expenditures in 1960-61 NFS, 117, USDA ERS (August, 1966), pp. 37-44.

The article provides an analysis of Survey of Consumer Expenditures 1960-61. Results of SCE are compared with the 1955 Household Food Consumption Survey. Summaries of spending patterns are presented with respect to levels of income, to regions and to family sizes. Food expenditures were also discussed with respect to income, family size, by urbanization, and by region.

A. C. Manchester. "Total Consumer Spending of Fresh Versus Processed Foods Remains Stable." NFS, 144 (May, 1973), pp. 35-39.

The past two decades have witnessed surprisingly little change in total consumption of foods according to whether they are fresh or processed. Fresh products increased from 36.4 percent of total consumption expenditures in 1952 to 38.6 percent in 1971. Products preserved but not otherwise changed, decreased from 30.7 percent to 29.1 percent. Derivative products decreased from 10.5 percent to 10.0 percent between 1952 and 1971. Comminuted products (manufactured products with several ingredients) were about the same--22.4 percent vs. 22.3 percent.

"New Directions in Food, Clothing, and Shelter." CBR (May, 1972), pp. 44-49.

D. B. Suits. "The Determinants of Consumer Expenditures: A Review of Present Knowledge." in Impacts of Monetary Policy, one of the research studies prepared for the Commission on Money and Credit, (Prentice Hall Inc., 1963).

"USDA Forecasts Food Output." National Agricultural Outlook Conference in FE (April, 1973), pp. 86-92.

Per capita food consumption in 1973 is expected to set a new record. At the same time, retail food prices are likely to rise about 6 percent above 1972. Food prices rose in 1972, although consumers had one of the sharpest boosts in purchasing power in several years.

Laura Mae Webb. "Changing Patterns of Consumer Expenditures." Survey of Consumer Expenditures 1960-61, BLS Report No. 238-5 (March, 1964).

Changes in urban family spending patterns between 1950 and 1960 are surveyed. Families spent more for all food and away from home foods, but food spending as a share of consumption expenditures declined from 29.7 percent to 24.4 percent and away from home spending declined from 5.7 percent to 5.1 percent of consumption expenditures. This was due to the fact that the income of the average urban family increased 49 percent between 1950 and 1960.

Laura Mae Webb. "Food Expenditures of Urban Families 1950 to 1960-61." Survey of Consumer Expenditures 1960-61, BLS Report No. 238-9 (May, 1965).

Average annual food expenditures of urban families increased 16 percent from 1950 to 1961. During this period, retail food prices measured by the Consumer Price Index increased 18.9 percent. Therefore the average urban family spent less in constant dollars in 1961 on food than in 1950, a surprising decrease since income was rising over the period. The decline is attributed to a decrease in consumption of food types for which prices rose more than average and an increase in consumption of food types for which price increases were negligible. The value of all food consumed by urban families is not reflected by the BLS survey. Food received as gifts, school lunch programs, and expense account eating increased. Thus the BLS survey understates the value of food consumed.

Irene H. Wogamot. "Trends in Buying and Using Food." USDA ARS (1968), 10 pp.

C. Demand Analysis

Bruno Baldini. Irreversibility and Demand Functions for Agricultural Products, Ph.D. Thesis in Ag. Econ., Univ. of California, (September, 1966), 264 pp.

W. K. Boutwell and R. L. Simmons. "Estimation of Demand for Food and Other Products Assuming Ordinally Separate Utility." AJAE Vol. 50, No. 2 (May, 1968), pp. 366-378.

The article presents an econometric model for the estimation of demand and income elasticities of food and other products. Actual numerical estimates are derived for durables, non-durables, services, dairy products, meats, cereals, and fruits and vegetables. All income elasticities are positive and all of the inherent price elasticities negative, as expected by the author.

G. E. Brandow. "Interrelations among Demands for Farm Products and Implications for Control of Marketing Supply." Pennsylvania Agricultural Experiment Station: (University Park: Bulletin 680 (August, 1961).

The author presents a consistent integrated description of the demand structure for farm products. Spelled out mathematically are price quantity relationships for numerous farm commodities. The study covers both the retail and farm levels of demand. Per capita food consumption over time has been influenced by the level of income, decline in manual labor, the shift of population from farm to city, reduced waste in processing, and better control of body weight. These apparently are causing per capita food consumption to decline 0.08 percent annually.

M. C. Burk. "Development of a New Approach to Forecasting Demand." AJAE, Vol. 46, No. 3 (August 1964), pp. 618-32-.

M. C. Burk. "An Economic Appraisal of Changes in Rural Food Consumption." AJAE, Vol. 40, No. 3 (August, 1958), pp. 572-590. See Bylund, pp. 178-179.

M. C. Burk. "Problems in the Analysis of Food Consumption." in U.S. Ag. Mkt'g. Service, Ag. Econ. Report, Vol. 6, No. 1 (January, 1954), p. 10-19.

Chao-Chen Chen. Reliability of Demand Equations for Farm Products in Future Time Periods, M.S. Thesis, Agricultural Economics and Rural Sociology, The Pennsylvania State University (January, 1960).

Models predicting demand for meats, livestock products, cotton, and wheat were tested by regression analysis using variables as price, total DPI, per capital disposable income and the consumers price

index. Findings were that the error of prediction is larger through time due to increasing inapplicability of values for exogenous variables. Also demand models using logarithms of variables appear to be better predictors than those using actual values.

W. W. Cochrane and H. C. Lampe. "The Nature of the Race Between Food Supplies and Demand in the United States, 1961-1975." AJAE, Vol. 35, No. 2 (1953), pp. 203-22.

Jean Crockett. "Demand Relationships for Food" in Proceedings of the Conference on Consumption and Savings. Irwin Friend and Robert Jones, eds. Wharton School of Finance and Commerce, University of Pennsylvania, 1960.

Rex F. Daly. "Demand for Farm Products at Retail and Farm Level, Some Empirical Measurements and Related Problems," JASA, Vol. 53 (September, 1958), pp. 656-668.

Expenditures for food at the retail level are fairly responsive to changes in consumer income. The use of food products as they come from the farm are relatively unresponsive to price and income changes. Data on retail expenditures for food, the marketing bill, and the farm value are used to present empirical measurements of price and income elasticities of demand, the flexibility of expenditures relative to income, and the interrelationships among these elasticities. Income elasticity for all food was about 0.5 and for food away from home about 0.9 A 10 percent increase in income is associated with a 9 percent increase in the marketing bill.

M. A. Girshick and T. Haavelino. "Statistical Analysis of the Demand for Food: Examples of Simultaneous Estimation of Structural Equations." Econometrica, Vol. 15, No. 2 (1947), pp. 79-110.

K. A. Fox. "Changes in the Structure of Demand for Farm Products." AJAE, Vol. 37, No. 3 (August, 1955), pp. 411-428. See Bylund, p. 179.

H. S. Houthaker and L. D. Taylor. Consumer Demand in the United States: Analysis and Projection, 2nd ed. (Cambridge: Harvard University Press, 1970) 321 pp.

This monograph is an econometric demand study for projecting all items of United States private consumption expenditures, particularly in 1970. The dynamic model on which most of the work is based generalizes an idea adopted in demand studies for durables: that current purchases depend not only on current income and prices, but also on the pre-existing inventory of the item. For nondurable commodities, habit formation is the exact counter part of stock adjustment. Demand equations were selected for 83 commodities including food purchased for off-premise consumption, alcoholic beverages, purchased meals, food furnished government and commercial employees, and food produced and consumed on farms.

L. Jureen. "Long Term Trends in Food Consumption: A Multicountry Study." Econometrica, Vol. 24, No. 1 (January, 1956), pp. 1-21. See Bylund, p. 181.

G. M. Kuznets. "Measurement of Market Demand with Particular Reference to Consumer Demand for Food." AJAE, Vol. 35, No. 5 (December, 1953), pp. 878-895.

Corrine LeBovit. "U.S. Food Consumption: Annual Disappearance and Household Survey Data." NFS, 126 (November, 1968), pp. 32-41.

Food consumption data derived from household surveys were compared with time series data, after adjustments were made to make the sets of data consistent. Time series data are compiled yearly using the disappearance method to determine food consumption. After adjustment, trends in consumption implied by household survey data were usually consistent with those based on time series disappearance data.

Marc Nerlove. Distributed Lags and Demand Analysis for Agricultural and other Commodities, USDA, ERS, Agr. Handbook 141 (1958).

This publication summarizes available literature on the use of distributed lags in the analysis of demand for individual commodities and contributes a substantial amount of new material to the problem of estimating dynamic demand relationships. Although distributed lags have been used in the analysis of some economic problems to this date they have been rarely used in connection with demand analyses. These techniques appear to be useful in measuring long-run and short-run demand functions. Several applied examples are discussed in detail. Considerable emphasis of this report is placed on methodological aspects, in part to call attention to problem areas.

Marc Nerlove and William Addison. "Statistical Estimation of Long Run Elasticities of Supply and Demand." AJAE, Vol. 40 (1958), pp. 861-80.

Using statistical methods of analysis the authors attempt to establish price elasticities of supply and demand and income elasticities of demand for various food commodities. The most significant finding of the paper is that evidence of serial correlation of residuals of the estimated supply or demand relationships is reduced or eliminated entirely. The reason for the difference between the dynamic and static approaches is explained in terms of the economic significance of the model employed. The methods thus presented offer an economic solution to a problem which has been treated in purely statistical terms.

James Tobin. "A Statistical Demand Function for Food in the USA." J. Royal Statistics Soc. 108, (Ser.-A) (1950), pp. 113-141.

William H. Waldorf. "The Demand for and Supply of Food Marketing Services." AJAE 48: No. 1 (February, 1966), pp. 42-60.

The article is concerned with estimating changes in the demand and supply of food marketing services in order to explain the decline in the farm share of U.S. consumption expenditures for food. From 1929 to 1962 there was no real increase in the price of food marketing services, because the supply of marketing services kept pace with demand. Of the decline in the farm share of consumption expenditures one-third is due to an increase in demand for food marketing services and two-thirds to agricultural production increasing faster than demand.

William H. Waldorf. "Demand for Manufactured Foods, Manufacturer's Services and Farm Products in Food Manufacturing." USDA ERS Tech Bulletin 1317 (December, 1964), 60 pp.

This study employs a simple econometric model to explain household behavior toward increased consumption of processed food and the decline of the farm share of the food dollar. More specifically it estimates three demand relations associated with domestic civilian consumption or processed farm food products: (1) A demand relation facing manufacturers for total manufactured farm foods, (2) a demand relation facing manufacturers for total food manufacturers' services, and (3) a demand relation facing farmers for total farm products consumed in food manufacturing. Primary interest is with (2).

A major finding was that the demand of households for factory processing services increased between two and three times for the period studied (1929 to 1950's). Real per capita income was the only significant variable associated with the shift in demand. The estimated income elasticities for food manufacturers' services was 0.86, for farm food products used in manufacturing 0.35, and for manufactured food products 0.57. The income elasticity for manufactured food products is the weighted sum of the other two. Also, household purchases of factory processing services respond about as much to price changes as they did with income.

The article includes a study of the effects of an expected income series on consumption based on the concept of an average economic horizon for all consumption. On the whole, the results show that such a study is inappropriate for the foods and services included in the study. The bibliography provides a list of literature pertinent to the economics of food consumption.

D. Forecasts

"The Consumer Market in 1980: Nondurable Goods," CBR (March, 1972), pp. 43-45.

"Current Trends in Consumer Markets," CBR (May, 1970), pp. 23-26.

Forecasts the market for food in 1970's.

The U.S. Economy in 1990, Conference Board Report 535 (1972), 31 pp.

III. A. Increasing Marketing Costs

O. P. Blaich and L. F. Hermann. Perspectives on Farm Product Marketing, Marketing Economics Division, ERS, USDA, Report 313, (1966), 27 pp.

This report considers primarily the supply of farm products for consumption. However factors which cause changes in the level of consumption are discussed such as the quantity of services embodied in commodities, effects of income, and rising prices.

Hazen F. Gale. The Farm Food Marketing Bill and Its Components, USDA, ERS, Ag. Econ. Report No. 105 (January, 1967), 58 pp.

The total increase in the marketing bill from 1929 to 1963 was caused by growth in the volume of food handled and in unit marketing charges. Larger volumes accounted for 42 percent and higher unit charges for 58 percent of increase in the marketing bill. Fruits and vegetables had the largest marketing margins, meats were ranked second, and bakery and cereal products third. Poultry and eggs had the smallest marketing bill. Retailers accounted for 44 percent of the total marketing bill in 1963 (including eating out places), processing 39 percent,distribution 17 percent. The volume of products sold by retailers including eating places increased faster than total volume of food markets. More specifically, the proportion of food handled by restaurants and other eating places increased relative to the proportion handled by retail sales. This report contains an excellent bibliography.

George W. Ladd. "On Some Measures of Food Marketing Services." JASA, Vol. 56 (March, 1961), pp. 65-69.

Some economists have applied multiple regression analysis to national aggregate time series to measure elasticities of demand for all food marketing services. This paper demonstrates the inappropriateness of the measures of marketing services; price, quantity and value used in the analyses. The service price index used was actually a services value index; the services quantity index used was an index of food quantity; and the measure of value used contained errors of observation of such a nature as to lead to biased elasticity estimates. Finally formulas are suggested which might be used for the construction of a Laspeyre's index of service prices and a Paasche index of quantity services.

F. V. Waugh and K. W. Ogren. "An Interpretation of Changes in Agricultural Marketing Costs." AER, Vol. 51, No. 2 (1961), pp. 213-224.

Consumers are not buying the same basket of food that they purchased twenty or thirty years ago. They are buying foods that are more highly processed and sold in fancy packages. They are buying more food in restaurants and more of their food is purchased and less comes from home gardens. Thus the total amount of money spent by consumers for food has gone up more than has the cost of a standard market basket.

William H. Waldorf and Jeanette Findlay. "Prices of Intermediate Goods and Services used in Marketing Farm Foods." USDA, ERS, Marketing Transportation Situation (May, 1962).

To perform the multitude of services required in marketing domestic farm food products, assemblers, processors, wholesalers, retailers, and away from home eating places buy a wide array of goods and services from nonfarm businesses not directly engaged in marketing food products. The article presents a newly constructed index showing changes in prices of intermediate goods and services. Increases in the prices of these goods and services that are not offset by increases in productivity result in higher costs of food marketing services. The purpose of the index is to provide a link between consumer demand at the retail level and the marketing system's demand for food at the farm level.

B. Market Structure

Agricultural Markets in Change, Marketing Economics Division, USDA ERS, Ag. Econ. Report No. 95 (July, 1966) 396 pp.

Agricultural marketing has changes in response to many stimuli. There have been innovations at all levels of manufacturing and retailing such as increased processing and fast food restaurants. These changes are enumerated and related to other socioeconomic variables such as changes in the level of competition, population, the labor force, income, education, leisure, and changes in consumption patterns. Aspects of theoretical economics dealing with innovations and market expansion are discussed and related to marketing agricultural products. About two-thirds of the study is given to the development of marketing techniques for various commodities. Problems considered are marketing channels, transportation, processing methods and costs, prices, market power, changes in the retail market, and some projections based on specific market and overall economic conditions.

Paul L. Farris, ed. Market Structure Research, Theory and Practice in Agricultural Economics (Ames, Iowa: Iowa State University Press, 1964).

This book deals with labor productivity as well as other topics and seeks to establish a basis for evaluating the performance of the food industry.

Food from Farmer to Consumer, Report of the National Commission on Food Marketing (June, 1966), 203 pp.

The report deals mainly with the structure and concentration of the food industry. Chapters 1 and 2 give a brief summary of consumer expenditure patterns. Changes in food marketing are due to changes in technology or in changes of economic variables influencing marketing conditions.

The Food Marketing Industries: Recent and Prospective Structural Changes. Marketing Economics Division, ERS, USDA, Report 295 (1966), 63 pp.

One outstanding characteristic of the food marketing industries has been growth. A significant structural change accompanying this growth has been the rise of super markets and large food retailing organizations. Eating places have gained an increasing proportion of the consumers food dollar. Between 1963 and 1965 sales of eating places grew 50 percent faster than grocery store sales.

Richard H. Holton. The Supply and Demand Structure of Food Retailing Services, Harvard Studies in Marketing Farm Products, #10-18 (June 1954), 64 pp.

The objectives of the study are not only to explain the nature of demand services associated with food retailing but also to examine characteristics of the equilibrium that is strict between service grocery stores and the limited service stores. A case study method was used. A Massachusetts town of nearly "typical" characteristics was selected. Data were collected for all food retailers operating at the time of the study and for all grocers operating in 1940. This study points to the conclusion that the income elasticity of demand for credit and delivery service is neither clearly positive nor negative; rather there is evidence that the demand for credit is concentrated in the upper middle-income brackets whereas the demand for delivery service shows only the slightest indication of the same pattern.

R. L. Kohls. "The Place of Merchandising and Promotion in Expanding Demand for Food." AJAE, Vol. 37, No. 5 (December, 1955), pp. 1380-1386.

R. L. Kohls and W. D. Dunny. Marketing of Agricultural Products 4 th ed. (New York: The MacMillan Co., 1972).

A framework for the marketing of agricultural products is established by considering the flow of goods through the food industry. One chapter discusses the determinants of consumption of agricultural commodities. Another chapter outlines marketing costs. Sources of information about all aspects of production and consumption are discussed.

Robert E. Kuenne. Monopolistic Competition Theory: Studies in Impact, (New York: John Wiley, 1967).

R. J. Minichiello. "The Real Challenge of Food Discounters." JM, Vol. 31, No. 2 (April, 1967), pp. 37-42.

In recent years retail food outlets, called discount foodstores, have appeared claiming to sell food at prices lower than those of conventional food supermarkets. The findings of the study indicate that discount foodstores reduced operating expenses mainly by eliminating trading stamps, and that food discounting is actually a marketing strategy. Conventional supermarkets spend $65,000 to $70,000 per year on trading stamps. The money could have been used for many different things. Discounters chose to reduce prices. The effect is that consumer choice is widened, since some consumers would rather have lower prices than stamps.

John R. Moore and Richard G. Walsh, eds. Market Structure of the Agricultural Industries (Ames, Iowa: Iowa State University Press, 1966).

Presented here is a representative up-to-date view of the agricultural industries at all levels and their diverse and evolving market conditions.

D. I. Padberg. Economics of Food Retailing (Ithaca: Cornell University Press, 1968).

Contained in this book is an analysis of the food retailing sector, its structure, behavior, and performance. The conclusion is that performance of the retail selling market is excellent. Consumers are provided with alternative types of service, clean and attractive facilities, a variety of merchandise, convenient location and hours of operation, at prices which cover cost and reasonable profits.

D. I. Padberg and T. David McCullough. "Toward the Year 1985: Food Wholesaling and Retailing." Special Cornell Series No. 6 (Ithaca, 1969), 12 pp.

This analysis anticipates a 1985 food retailing and wholesaling industry which looks and acts very much like the present. Major forces for change from the past--the chain store movement and the supermarket--have received a rather complete response from the industry. Major changes within the industry have given way to slow but steady evolution of minor improvements. No revolution seems imminent. The next change of revolutionary proportions is expected to affect the congested urban areas, but it will not be a major factor within the next 15 years.

C. Labor, Technology, and Innovation

1. Labor and Productivity

Jack Bloom. "The Food Technologist in the Food Service Industry: Need, Challenge, and Prospects." FT (September, 1969) p. 39.

Due to the rapid growth of the food service industry, the food processing industry has begun to orient more of R and D activities to this market. Three problems faced are the diversity of the food service industry, lack of good market research, and rapid change in the food service industry. Only 30 percent of firms replying to a survey employed food technologists. Generally they were firms that did some of their own processing.

George F. Bloom. Productivity in the Food Industry (Cambridge: MIT Press, 1972), 313 pp.

The food industry contains the potential for a substantial acceleration in the rate of productivity advance in the seventies. However, the various institutional, legal, and systems barriers are such that it is unlikely that the actual date of change in man hour output will vary materially, unless government promotes a more rapid rate of progress through appropriate policies.

J. F. Booth. "The Influence of Consumption Changes on the Use of Resources and on Technical Change in Agriculture," in International Conference of Agricultural Economists: Proceedings 9th (1955), pp. 221-238.

C. King Emma. "Labor Cost and Productivity in Hospital Food Service." CHRAQ, Vol. 12, No. 1 (May, 1971), pp. 47-52.

Measurement and analysis of labor cost in relation to productivity are becoming of increasing concern to food service management. Wage increases in food service operations are rarely accompanied by commensurate increases in productivity. Therefore, the increased labor costs have two effects. One is the attempt to replace the use of labor. Second is increased care in the use of labor resources and efforts to eliminate excessive labor costs.

W. Fogel. "Union Impact on Retail Food Wages in California." IR, Vol. 6 (October, 1966), pp. 79-94.

This article establishes that a high degree of unionism has brought about sizable increases in the relative earnings of food establishment employees in California between 1941-1962. The impression of union and employer spokesmen is that higher quality work forces have accompanied higher wages in the food industry and that a higher quality labor force has contributed to productivity increases measured in the paper. Two factors give an inelastic characteristic to the demand for labor. The possibility of competition from non-union firms are slight and labor costs are only 7 to 10 percent of the total costs for most firms.

Robert E. Freeman. "Role of Farm Productivity and Marketing Margins in Postwar Decline in Farm Prices." AJAE, Vol. 48, No. 1 (February, 1966), pp. 31-41.

Several commodity groups showed marked differences in the changes in farm and retail prices, in marketing margins, and in quantities produced in 1961 to 1963 as compared with 1947 to 1949. By constructing a consistent and rational set of supply and demand curves through price quantity points, shifts in the farm supply and demand and retail demand curves for various commodity groups have been indicated. Fruits and vegetables have been least adaptable to mechanization and the farm supply function shifted only slightly. Consumers have had to pay more to cover higher farm prices and increased marketing margins. By contrast there have been tremendous technological advances in poultry production. This is consistent with the large shift in the supply function. Market margins were almost always constant so the gains in production efficiency have been passed on to the consumer in the form of lower prices and increased volume. The shifts in the supply functions are generally consistent with changes in output per man hour.

D. R. Fusfeld. "Population Growth and Employment in the Service Industries." SEJ, Vol. 35 (July, 1968), pp. 73-77.

In percent years the proportion of persons employed in the service industries has increased until now it exceeds the work force in manufacturing. The share of disposable personal income spent on services has increased, while that spent on goods has fallen. The aim of this paper is to show that the major determinant of employment growth in the service industries is the increase in population and that increases in income have only an inconsequential effect.

The growth of employment in service industries and in median family income were examined for 23 major metropolitan areas between 1950 and 1960. One would expect the cities with the largest gain in income to show the largest increase in service employment. No systematic pattern appeared and the assumption was sustained that income had an inconsequential effect.

"Future Food Service Executives Get First Taste of Frozen Convenience Foods Concept." QFF (February, 1973), p. 30.

A model laboratory for testing frozen convenience foods and reconstituting equipment has been set up by the Department of Food Service, University of Wisconsin, to prepare students for careers as food management executives. University educators believe that the food industry's greatest need in the future will be people trained on the food management level, rather than as kitchen technicians.

J. A. Ghene and Leo Nejelski. "Food Service Systems: Human Factors in Administration," CHRAQ, Vol. 11, No. 1 (May, 1970), pp. 49-56.

Changes in the technology of food service have made changes in food purchasing, handling, preparation, service and sanitation. Responsible decision makers in the food service industry need to renew their understanding that congenial and productive relations are conditioned by understanding and by the maintenance of self respect. But how to use labor saving technology without dehumanizing workers is a major problem

Gerald W. Lattin. "Manpower Projections for the Food Service Industry," CHRAQ (May, 1969), pp. 49-52.

McKinsey & Co., Inc. Report: An Identification of Problems in Food Industry Management. Prepared for National Association of Food Chains (New York, 1962), 36 pp.

People, Productivity, Profits, CHRAQ, Vol. 8, No. 1 (May, 1967).

This volume is concerned with sources of labor and low productivity, and their effects on profits. Some of the articles of interest to food service follow: J. Cribbin, "Innovational Thinking--Fulcrum for Organizational Growth"; J. J. Zaffy, "How to Live with Unions"; J. Counts, "Management's Role in Worker Productivity"; F. J. Harberi, "A Case History in Hiring Slow Learners"; M. B. Burritt, "Projected Labor Costs in Future Food Systems"; R. Willett, "Today's Convenience Foods"; Parrott, "Airline Food Service"; A. R. D'Agostino, "Airline Food Service Problems."

Thomas F. Powers. "Labor Supply, Labor Costs and Change in the Hospitality Industries." unpublished paper.

Labor costs of food service and housing industries have undergone radical change in the past few years. A tight labor market and the social welfare policies of state and federal governments have caused the wages of labor to rise substantially. Wages have not been rising in the hospitality industries as fast as all wages in the rest of the economy. Thus the level of benefits derived from working in the hospitality industries is approaching the minimum welfare benefits provided by the state, since they have risen dramatically. Wage costs are substantial in service industries. Rising wages have not been offset by productivity increases as in the rest of the economy. Therefore, the rising wage costs have a greater effect on the cost of the service produced than to rising wages in manufacturing. Since the hospitality industries are labor intensive and welfare policies make it difficult to attract labor at low wages, there is an incentive for using less labor intensive methods of service.

R. W. Resek. "Investment, Production and the Cost of Funds." ASA Proceedings (Washington, D.C., 1967), pp. 371-380.

The model of investment behavior emphasizes the effect of the production function on investment and the use of investment analysis to discover information about that production relation. For the food industry the elasticity of substitution of capital and labor was very low. In addition, capital saving technology occurs at the rate of 4 percent per year. Internal financial variables play an important role in the timing of investment but do not affect the cost of capital.

The data employed for the analysis came mainly from Compustat Service offered by Standard Statistics Company, a subsidiary of Standard and Poors. Data was obtained for 23 firms in the food industry for a period of 19 years.

B. B. Seligman. "The High Cost of Eating." in Seligman Economics of Dissent (Chicago: Quadrangle Books, 1968), pp. 218-29.

Seligman believes that the consumer has a tremendous disadvantage when buying food due to structure of the industry. Competition is usually in such non-price areas as hours and services rather than in lower prices. The growth of horizontal and vertical integration has caused the food bill to grow, with no recourse for the consumer.

Marvin Spritzler. "Designing for Convenience." Vend (March, 1973), pp. 43-46.

The "Total System Concept" in which every component from food to production procedures are designed to work together for maximum efficiency involves two major types of decisions: menu decisions and production decisions. Cost will be a major factor in determining the extent to which a commissary uses convenience foods. Versatility of food and equipment are the keystones to planning a total systems commissary. Productivity in the food service industry is 0.12 percent compared with a national average of 3.5 percent. One effect of the systems approach is to allow for a smaller labor force.

Dale G. Stallings. Long Run Projections of Food Processing and Marketing in the West. Marketing Economics Division, USDA ERS, Ag. Econ. Report No. 78 (June, 1965), 45 pp.

A major objective of the report was to study changes in processing, wholesaling, and retailing of agricultural food products in the Western Region to project changes that might occur under specified conditions by 1985. Another objective was to examine some of the changes of processing and marketing costs.

Shifts are expected from fresh, relatively unprocessed foods to processed and from starches to meats. Productivity of labor in food processing has increased rather steadily at the rate of 2-4 percent. On the basis of the labor productivity estimates, employment is projected to increase only in processed fruits and vegetables and bakery products. From 1954 to 1985 sales of food stores are projected to increase 155 percent and sales of eating places 182 percent. Large increases in employment are anticipated for wholesale firms and retail food stores, with the largest projected increase for eating places.

"Training the Mentally Retarded." Hospitality (August, 1973), p. 71.

In 1965 a program was begun by Economics Laboratory in Minnesota to train mentally retarded persons for jobs in the food service industry. By 1970, the program had spread to 18 states and is being considered in others to bring the total to 32 states. Findings show the mentally retarded who are educable are better suited for routine tasks than the bright, ambitious person who becomes bored or impatient. The turnover rate is close to zero for trained mentally retarded personnel.

William H. Waldorf. "Labor Productivity in Food Wholesaling and Retailing 1929-1958," RESTAT 48 (March, 1966), pp. 88-93.

This paper is concerned with the growth of output and productivity in the food wholesaling and retailing of foods. Net output/man hr. grew at rate of 2.8 percent per year, 1929 through 1958. Food distribution grew at the rate of 2.5 percent per year. The difference of .3 percent is understated because away-from-home eating places which were included had smaller productivity gains and importance of away-from-home eating also increased.

W. H. Waldorf. Output of Factories Processing Farm Food Products in the U.S., 1909-58, USDA, Tech. Bul. 1223, no date, 43 pp.

William H. Waldorf. Output per Han-Hour in Factories Processing Farm Food Products, USDA Tech. Bul. 1243 (May, 1961), 36 pp.

From 1947-58 output per man hour increased 2.7 percent per year in factories processing domestic farm foods. Rates among industry groups varied widely: 4.6 percent in processing fruits and vegetables and 1.4 percent per year in bakery products manufacturing. The annual rate of growth of output per man hour in food processing was much lower than for the total private economy, 3.5 percent. Changes in the quality of labor through education, training, and experience contributed to growth in output per man hour. From studies of income elasticities of different food products, it appears that shifts in production from industries with higher levels of output per man hour to industries with lower output per han hour may continue.

William H. Waldorf. Productivity and Food Marketing Costs, USDA, Ag. Econ. Res., Vol. 14, (1962), pp. 30-34.

William H. Waldorf and Hazen F. Gale. Output Per Man-Hour in Distribution of Farm Food Products. USDA Tech. Bul. 1335 (1965), 24 pp.

Output per man-hour employed in distributing foods of domestic farm origin increased at an average rate of 2.5 percent per year from 1929 to 1958. For wholesaling and retailing the increase was 2.8 percent per year. The difference was due to a lower increase in output per man-hour in the other components of food distribution, away from home eating, coupled with a larger total increase in output during WWII. Gains in output per person were much sharper than gains in output per man-hour. The most important factor in the rise of labor productivity was the shift from clerk to self service stores.

2. Product Innovation

O. M. Adkins. "The Importance of New Products to Food Companies." FT, 19-10 (1965), pp. 50-54.

M. A. Benarde and N. W. Jerome. "Food Quality and the Consumer: A Decalog." AJPH, Vol. 65, No. 9 (September, 1972), pp. 1199-1201.

Few consumers are ever consulted about the foods that are or are going to be produced and marketed. Except for what consumers themselves take from the shelves, the food processor, research and development labs, and regulating agencies have a responsibility to provide for an adequate food supply. The above institutions in effect establish and regulate values and tastes for society. Generally the consumer expects them to take health, safety and tastes into consideration in preparing food. The consumer's Decalog is a series of requests directed to those who have assumed overall responsibility for food supply.

Guy Black. "Product Differentiation and Demand for Marketing Services." JM, Vol. 16, No. 1 (July, 1951), pp. 73-79.

R. D. Buzzell and R. E. M. Nourse. Product Innovation in Food Processing: 1954-1964 (Cambrdige, Mass.: Harvard University, 1967).

This study deals with product innovation and with some of the problems created by it in the food processing industries. Innovation has become a major dimension of competition among the larger food processors and thus an understanding of the nature and effects of new products seems essential in any attempt to explain or evaluate competition in food marketing. Ten percent of items first stocked after 1954 were items of a new type.

Kermit Bird. "Developing and Testing New Foods and Fibers." The Marketing and Transportation Situation, Vol. 155 (November, 1964), pp. 35-41.

K. Bird; P. B. Duosking; and M. E. Miller. Market Innovations, Marketing Economics Division, ERS, USDA Report 314 (1966), 27 pp.

Important marketing innovations of recent years include new foods, fibers, handling methods, and process. As a result entirely new industries are appearing. An increasing array of convenience foods are now available frozen, canned, and dehydrated. New machines handle particular products, and packaging improvements match advances in container filling. Some of the newer foods are possible because of container innovations. New methods are constantly being tried in the whole food industry. Retail functions are being centralized with more efficiency as the result. Vending machines and fully automated restaurants are innovations in the food service industry.

Gordon E. Bivens. "Household Use of Convenience Foods." in USDA, National Agricultural Outlook Conference (November 13-16, 1967), 11 pp.

"Convenience Foods" Hospitality (April, 1973), pp. R33-R52.

Convenience foods have been difficult to use in commercial restaurants if they were not used properly. To help solve the problem Hospitality gathered an expert panel to conduct convenience food menu analysis (CFMA). Recommendations for using convenience foods were that they should be used to broaden and diversify menus, rather than replace existing entrees. In effect, convenience foods allow expansion of consumer appeal and an opportunity to control labor costs.

"Convenience Foods." CBR (June, 1968), pp. 33-35.

Purchases of convenience foods by categories and as a percentage of household expenditures for food are given.

T. Finnegan. "Frozen Foods in Food Service: Market Growth, Product Usage, Expansion, Equipment Purchasing Plans." QFF (April, 1973), pp. 29-33.

The survey by QFF shows that many food service operators in all segments of industry are using 25-80 percent frozen foods in their food planning. Reasons for choosing frozen foods follow: New frozen convenience products can be tailored to individual needs, labor costs are reduced, better packaging reduces handling, and development of sophisticated equipment that cuts preparation time. Over 82 percent of food service contractors will hike usage of frozen foods by 5 to 40 percent with the majority opting between 5-15 percent.

Harold L. Franklin. "Retail Frozen Food Sales in 50 Leading Markets." OFF (January, 1973), pp. 47-49.

This study, based on the 1972 Frozen Foods Almanac, is a market-by-market breakdown of total frozen food sales and per capita consumption in dollars, with similar data for each of the seven major food categories: prepared foods, seafoods, poultry, vegetables, meats, juices and drinks, and fruits.

H. H. Harp and D. F. Dunham. "Comparative Costs to Consumers of Convenience Foods and Home Prepared Foods." USDA, Mktg. Res. Rpt. 609 (June, 1963).

Convenience foods include those foods which have been partly or entirely prepared for service by marketing agencies and which have a fresh or home prepared counterpart. These foods include such diverse items as frozen meals, cake mixes, dehydrated foods, canned foods, and instant beverages. Many convenience foods were more expensive than less processed forms, however the more expensive convenience foods account for a small volume of food sales. For the period under consideration, $14.03 of the grocery bill was spent on convenience foods. The cost of an equal quantity of fresh foods was $15.10 for every $100 spent on food. Thus $1.07 was saved by buying convenience foods. Time saving is an important factor in the acceptance of convenience foods and offsets the cost of many of the more expensive convenience foods. The importance of quality difference varies among consumers, depending on the food commodity.

Harry H. Harp and Miller E. Marshall. "Convenience Foods: The Relationship Between Sales Volume and Factors Influencing Demand." Marketing Economics Division. USDA, ERS, Agricultural Economic Report No. 81 (August, 1965), 22 pp.

This report identifies measurable factors associated with sales volume of convenience foods, and gives an equation based on these factors which may be of use in predicting the success of new products.

The estimating equation developed from available data explained 87 percent of variation in the log of sales of 110 convenience foods. Taking into account those factors found to be significantly associated with sales should be a positive aid in guiding the development and sales promotion of new products and in reducing the high rate of product failure.

The factors found to be significantly related to sales of convenience foods include costs per serving, degree of competition from similar products, importance of food group in the consumer purchase pattern, availability of the product, success of similar convenience foods, and special variables for specialty and ready-to-serve products. Quality and promotion are also important, but due to lack of data, these factors were not included in the analysis.

R. O. Herrmann; R. H. Warland and E. H. Carpenter. Consumer Adoption and Rejection of Imitation Food Products, Ag. Expt. Station Bulletin 779 (University Park, Pa., 1972).

E. J. Kelley. "The Importance of Convenience in Consumer Purchasing." JM, Vol. 23, No. 1 (July, 1958), pp. 32-38. See Bylund, p. 94.

McKinsey & Co., Inc. McKinsey-Birds-Eye Study: The Economics of Frozen Foods, White Plains, N. Y., General Food Corp. (1964), 42 pp.

L. Polopolus. "Synthetics, Substitutes, and Food Marketing." JM 31: No. 4 (October, 1967), pp. 12-17.

Synthetics and substitutes each have a different effect on the agricultural marketing system. Synthetic food products rely on non-farm inputs and therefore can potentially influence the agricultural economic community at large. Substitute food products use predominantly agricultural raw materials, requiring reallocations within the agricultural economy. This distinction between substitutes and synthetics is basic to evaluations of their effects on the total agricultural economy. The market value of synthetics was approximately 10 percent of the 1966 market value of agricultural production.

Corrine Robinson. Comparison of Preparation Time and Costs for Convenience and Home Prepared Foods. Drexel Inst. Technology, Philadelphia.

C. I. Sayles and H. A. MacLennan. "Ready Foods: The Application of Mass Production to a la Carte Food Service Using Prepared to Order Food." CHRAQ, Vol. 6, No. 2 (August, 1965), pp. 1-65.

"Ready Foods" is the term used to define a specific type of convenience food that can be kept for a convenient period in storage in individual portions. When ordered by a dining room patron, it can be finished and served within an acceptable time. It enables the food service kitchen to achieve higher productivity and allows the restaurant to operate with a wider menu variety.

J. P. Sweeney; V. J. Chappman, et al. Vegetables--Consumer Quality, Yield, Preparation Time of Various Market Forms, USDA Agr. Home Econ. Res. Rpt. 17 (1962).

J. P. Sweeney, et al. "Quality of Frozen Vegetables Purchased in Selected Retail Markets," FT, Vol. 15 (1961), pp. 341-345. "Quality of Frozen Fruit from Retail Markets," FT, Vol. 16 (1962), pp. 138-143.

W. W. Thulin and C. H. Grim. "The Trend is Toward Synthetic Flavors." FT, Vol. 23 (November, 1969), pp. 27-28.

Synthetic flavors appear likely to become one of the most dynamic segments of the food industry. Demand for new food sources and increasing intensity of flavor research are causing a number of fundamental changes. Among them: changes in the nature of synthetic flavors, changes in the consumer's viewpoint; and changes in relationship between manufacturers of synthetic foods and food processors.

D. W. Twedt. "What is a 'Convenient Foods'?" JM 31: No. 1 (January, 1967), pp. 67-68.

Foods sold through grocery stores can be classified as convenience foods by the economic criteria:

1. Value added by manufacture
2. Time or effort saved by the manufacturer's processing.

The definition of convenience food is "a food which because of processing and/or packaging is quicker or easier to prepare than in basic or standard form." From 1963-67 new food products should have accounted for one-half the growth of entire food industry.

Marshall C. Warfel. "Convenience Foods--What is the Score?" CHRAQ, Vol. 12, No. 1, pp. 33-38.

People who eat in the captive institutional market can be served many frozen cooked dishes they would not accept if they had a free choice. Guests in first class hotels and restaurants who represent under 10 percent of the total eating out market, do not yet accept most of the items obtainable from suppliers. Because the market is relatively small in relation to the institutional field, efforts to develop acceptable products have lagged.

J. E. Wickersham. "Food Processing and the Developing Society." in The Challenge of Development, R. J. Ward, ed. (Chicago: Aldine, 1967).

The purpose of this monograph is to illustrate technological, social and economic benefits that have accrued to countries that have developed food processing industries and to relate these experiences to the particular needs and conditions in developing countries. Food processing and recent innovations in food technologies are discussed and its benefits are appraised for nations with food processing industries. The most practical method to introduce new technology in an interested country is to get incentives from the native government, develop local interest and initiative in the interested country, and secure private outside sources of technology.

IV. Away-from-Home Food Market

A. Away-from-Home Food Consumption

Ronald S. Edwards and Henry Townsend, eds. Business Growth (New York: St. Martins Press, 1966).

Case studies of firms in the food processing and retailing industry in Great Britain are presented. The development of the confectionery industry, catering, ice cream manufacturing and selling, and brewing are discussed.

Corrine LeBovit. "Expenditures for Food Away from Home." NFS 122, (November, 1967), pp. 42-48.

The data sources of the report are the 1955 and 1965 USDA Household Food Consumption and the USDA Survey of Market for Food Away from Home. Sixty percent of away from home food expenditures go to eating and drinking places, 20 percent to institutions, 10 percent to hotels and motels, remainder to other establishments. Consumer expenditures for eating out rose faster than population and faster than home food expenditures. Most of increased spending was for meals, not snacks. Prices of food away from home have followed all consumer services. City families spent more than rural families, families in the Northeast spent the most on eating out. Expenditures for meals away from home is more closely related to income than snacks eaten away from home. Average expense for meals out have little relationship to family size. Families of 3 or 4 spent slightly more than larger or smaller families. Greatest proportion of families receiving meals without expense was among rural non-farm families. Total constant dollar expenditures for food away from home changed little between 1955 and 1965.

Corrine LeBovit. "Foods Eaten Away From Home." NFS 132 (May, 1970), pp. 25-31.

U.S. household members reported on their food consumption for one day in spring of 1965. Proportions of various food categories eaten away from home varied little among regions or by degree of urbanization, but quite a bit in direct relation to family income. The proportion of food away from home was 16 percent of total food consumption. Proportions for individual food categories eaten away from home are presented.

Seven percent morning meals were eaten out, 23 percent of noon meals, and 10 percent of evening meals. Items consumed the most are candy and beverages, next, meat products, ice cream and sweet pastrys. Other foods ranged between 10 and 15 percent being eaten away from home. Income, urbanization, and regional differences are discussed.

Corrine LeBovit. "The Changing Pattern of Eating Out." NFS 144, (May, 1973), pp. 30-35.

Expenditures for food away from home in the United States have doubled since 1960 with most of the change due to higher prices and population growth. However, the proportion of sales has been increasing at places with relatively low prices per transaction such as refreshment places, cafeterias, and vending machines and decreasing at restaurants. Americans are eating out more often but not necessarily meals.

B. Food Service Industry

M. B. Burritt and I. E. Markham. "The Food Service Industry: Where are We Headed?" Hospitality (July, 1973), pp. R35-R43.

There was a 9 percent increase in sales in the public segment of the food service business in 1972. After adjusting for price increases the gain was 4 percent, making 1972 one of the best in recent years. Center city restaurants continue to have serious problems, forcing many old, familiar operations to close. Fast food establishments continue strong growth. Showing the greatest improvement were restaurants in suburban locations.

Change--The Pace Quickens, CHRAQ, Vol. 12, No. 1 (May, 1971).

"Change--The Pace Quickens" is the title given to the entire May issue, which is primarily concerned with change in the food service industry. Problems discussed in several articles are the problems restaurants have with convenience foods, food service in hospitals and labor productivity, food service facilities, and employee training programs.

Anthony Downs. "Market Trends in Food Service." CHRAQ, Vol. 10, No. 2 (May, 1969), pp. 5-16.

"The Food Service Industry, 1971: Part I," NRA Washington Report (May 14, 1973).

In the food service industry in 1971 food and drink sales totaled $44.3 billion which indicated a jump of 7 percent from 1970 when sales totaled $41.4 billion. Commercial establishments were responsible for $36.6 billion or 83 percent of sales and 70 percent of the purchases of food and drink. A detailed breakdown of estimated food and drink sales and purchases is given for 1971.

"The Food Service Industry 1971: Part II." NRA Washington Report, (July 2, 1973).

Growth in the commercial feeding group in the interval 1970-71 was 7.18 percent versus an increase of 5.12 percent in food and drink sales for the non-commercial group. The most significant trend in the restaurant area is rapid growth of operations which use limited menu fast food operating techniques but employ dining atmosphere and merchandising concepts. Sales data and percent change in sales are depicted for many types of retail food outlets.

Corrine LeBovit. "Food Use by the Food Service Industry." NFS 142 (August, 1972), pp. 28-30.

The food service industry used an estimated 14 percent of the food available for civilian consumption in 1969. The proportion varied from 5 percent for the dry beans and nuts to a high of 21 percent for fats and oils. These estimates were based on data obtained in 1969 USDA Survey of the Market for Food Away from Home. Institutional outlet which were excluded might increase food service statistics by one-third.

The Survey of the Market for Food Away from Home is probably a more accurate indicator of the proportion of commodities eaten away from home than the Household Food Consumption Surveys. It measures foods supplied to the food service industry.

Roslyn Willett. "What is Happening in Food Service." FF (October, 1969), pp. 111-112, 114.

The food service industry is growing faster than population. Segments of the industry growing fastest are commercial food services, simplified services restaurants, hospitals, schools and colleges, and recreation markets. Use of convenience foods have permitted the use of a systems approach and greater ease of handling through better packaging.

M. G. Van Dress. The Food Service Industry: Its Structure and Characteristics, 1966, Ag. Stat. Bull. 416, ERS USDA (1968).

Michael G. Van Dress. The Food Service Industry: Type, Quantity and Value of Foods Used, Ag. Stat. Bull. 476, ERS USDA (November, 1971).

M. G. Van Dress and William H. Freund. Survey of the Market of Food Away from Home, USDA ERS-197 (May, 1967).

C. Restaurants

"Eating and Drinking Place Industry--First Half 1973." National Restaurant Association Washington Report (August 27, 1973).

During the first half of 1973, eating and drinking places sales expanded 11 percent per year. Prices of food away from home were up 5 percent due to rapidly rising wholesale food prices. From May 1972 to May 1973 the number of employees in eating and drinking places increased by more than 140,000.

"Restaurant Industry: A Round Table Discussion," The Wall Street Transcript (November 12, 1973).

Five Wall Street analysts discuss the profitability of the food service industry. The value of food spending away from home is 30 percent of all food spending. Four types of food service organizations are distinguished: fast food, coffee shops, limited menu dinner houses, and a miscellaneous catchall group. Fast foods are the fastest growing because of new products and new marketing techniques. Companies with good outlooks for the future exist in each of these four types.

Lester C. Satorius and Marguerite C. Burk. "Eating Places as Marketers of Food Products." USDA Mktg. Res. Rept. 3 (1952). 118 pp.

The purpose of the study was to investigate the role of eating places as marketers of food products. In 1948, 16 percent of civilian food supply of the U.S. was marketed through eating places. Many small restaurants buy supplies at retail outlets or at higher wholesale prices than retail outlets. Eating places sell food, services, and the use of capital and charges for labor and capital often exceeds the cost of food. Efficiency is difficult to measure because of differing amounts of services offered at different types of eating places. Meals in department stores and liquor stores tend to be subsidized by the proprietor to attract customers. A large proportion of meals, 59 percent, was served by 18 percent of the establishments in Minneapolis in 1948. Actually the bulk of the report was an indepth case study of the eating place industry in Minneapolis with the expressed hope being that the results would encourage further research.

Hayden Stone Inc. The Specialty Restaurant Industry (1973), 49 pp.

An overview of the food service industry is provided. The specialty restaurant industry is growing as rapidly as GNP, making it one of the fastest growing sectors of the food service industry. An econometric forecast of retail food sales shows that 80 percent of the change in sales can be predicted with the following variables: disposable personal income, the unemployment rate; ratio: cost of eating out to cost of eating at home; resident population of U.S.

Gene Yetter. "Restaurant Growth Index--Part I." FF (September, 1973), pp. 77-92.

Using 1971 data issued by the National Restaurant Association, Fast Food adds information gleaned from its 1973 survey of food service operators to present an indepth look at nine markets: commercial, retail, leisure, business/industry, student, transportation, hotel-motel, health, and specialized areas. Each market segment is outlined with trends, a menu and services profile, a list of market leaders, plus 1971 NRA sales data.

E. J. Spar. "Restaurant Growth Index--Part II." FF (September, 1973), pp. 124-152.

Commercial restaurant sales data for particular markets have been collected for 295 metropolitan areas. Generally the wealthier a community the higher eating and drinking expenditures as a proportion of all food expenditures were.

D. Fast Food

John Farley. "Why Does Brand Loyalty Vary Across Products?" Journal of Marketing Research, Vol. I, No. 4 (November, 1964), pp. 1-9.

"Franchising: What it Takes to Get a Piece of the Action." Hospitality (December, 1973), pp. R27-R35.

There is solid growth potential in food franchising. The food franchising market is relatively undeveloped. There are only 30,000 fast food restaurants compared to 220,000 gas stations. Thumbnail sketches of leading fast food companies are provided showing how fast they have grown. Companies discussed are A&W Rootbeer, Arby's, Bonanza, Burger King, Dunkin Donuts, Hardees, Dairy Queen, International House of Pancakes, Kentucky Fried Chicken, Lums, McDonalds, Mister Donut, Mr. Steak, Pizza Hut, and Shakey's.

Ronald E. Frank. "Is Brand Loyalty a Useful Basis for Marketing Segmentation." Journal of Advertising Research, Vol. VII, No. 2, (June, 1967), pp. 27-33.

This article provides a comprehensive review of the literature on brand loyalty.

R. E. Frank; S. P. Douglas; and R. E. Polli. "Household Correlates of 'Brand Loyalty' for Grocery Products." JB, No. 41 (April, 1968), pp. 237-245.

Based on Stigler's economics of information, seven assumptions for brand loyalty are made: (1) one would expect heavy buyers to be less brand loyal than light buyers; (2) high-income households would exhibit more brand loyalty faced with a greater opportunity cost of time cost; (3) for a given income level, large families would be less brand loyal; (4) higher than average level of car ownership might be associated with less brand loyalty, car ownership is positively correlated with the number of stores in which one does business; (5) working wives will tend to exhibit a greater degree of brand loyalty; (6) housewives with relatively little formal education may be more brand loyal; (7) non-white heads might be more brand loyal than whites, because there is a relative absence of modern chain stores in non-white areas. The findings do not consistently support the seven hypotheses. While the direction of the effects of such variables as family size and education tend to be consistent with expectations, the absolute magnitude of the partial correlation coefficients is small. Data used to test the hypotheses are based on data generated from a 1961 Chicago Tribune consumer panel.

Stephen C. Michaelides. "Profile of a Giant, A & W Rootbeer Inc.: In Rootbeer Veritas." Hospitality (September, 1973), pp. R45-R70.

A & W is one of the largest food franchise firms with about 2500 units, 1,100 more than McDonalds. But the firm was badly mismanaged. Consequently, the firm sought to reorganize and reshape its image to compete in the fast food market. The profile illustrates how food firms must change to keep up with consumer demands for convenience, menu variety, and inexpensive cost.

"Profile of a Market." FF (November, 1970), p. 95.

Charles I. Vaughn. "Survey of Fast Food Franchising." CHRAQ, Vol. II, No. 3 (November, 1970), pp. 20-27.

Huntley R. Whitacre. "The Fast Food Industry: A Study of Change." FF (May, 1969), pp. 70-76.

E. Other Food Marketers

Food Systems for Today and Tomorrow. CHRAQ, Vol. 6, No. 1 (May, 1965).

The entire volume contains articles dealing with trends in the food service industry such as the use of convenience foods and automation. Some of the articles include: J. D.

Le Sure and J. Terry Radigan, "Statistical Analysis in the Hospitality Field: The Need for Basic Research"; P. R. Broten, "The Food Service Industry 1960-1980"; A. C. Avery, "Human Engineering the Institutional Kitchen"; J. E. McDowell, "Economics of Automatic Food Vending"; and J. M. Blosser, "Efficiency Foods for the Food Service Industry."

Stephen Keck. "Recreation Market," FF, Special Report (January, 1973), pp. 59-69.

Food service operators interviewed by Fast Food expect a high rate of growth for recreation facilities throughout the country. Food service operators are cautious because good food seldom brings customers to a particular area, but quality food at a reasonable price will keep them coming back.

"Mobile Catering Survey." Vend (September, 1973), pp. 37-41.

Mobile catering retail sales went up 15 percent in 1972 to top $1 billion and served 1,150,000 locations. Nearly 80 percent of those responding to survey own their own food preparation commissary. There is rapid growth through new operations. Twenty-two percent of the respondents started their businesses between 1970 and 1973.

P. J. Parrott. "Perspective on Challenges in Airline Food Service." FT, Vol. 23 (December, 1969), pp. 41-46.

The challenges created by the scope of airline operations, the high cost of airline labor, and shortage of basic kitchen skills have forced airlines to pioneer in the use of convenience foods. The operation of an airport kitchen is always a problem. Food handlers would rather work closer to the end product where they can see buyer appreciation. The solution has been to purchase factory produced, pre-cooked, frozen foods of high quality and turn kitchens into assembly points.

F. Psychological Aspects of Eating Out

Graham Campbell-Smith. "Marketing the Meal Experience." CHRAQ, Vol. 11, pp. 73-102.

Food choice is highly personal, a matter of individual preferences, family customs, income, living conditions, mood, social occasion, etc. The selection of an establishment in which to eat away from home is affected by all of the above and the establishment's accessibility. Merchandising the meal involves sophisticated application of marketing principles. The author seeks to define the meal experience in relation to the five human senses and relate these factors to the various markets, institutions, fast food, luxury, entertainment, etc.

"Design: Man in His Own Image." Hospitality (April, 1972), pp. R21-R33.

To know design is to understand how it affects people. Only then does one begin to appreciate why it's as much a part of the ambience one wants to project in his restaurant as the food and service. Eating out should be a total sensual experience. Good design adds to the drama and pleasure of enjoying a good meal. But a restaurant begins with its menu. A restaurant should not be designed without knowing what the menu is going to be.

V. Consumer Behavior

A. Effect of Income

E. W. Bunkers and Willard W. Cochrane. "On the Income Elasticity of Food Services." Review of Economics and Statistics 39 (1957), pp. 211-217.

F. Bunting and C. LeBovit. "Percent of Income Spent for Food-Estimates from National Income and Household Survey Data." NFS 137 (August, 1971), pp. 22-28.

Several sources of data used to derive the percentage of disposable income spent for food are compared and reasons for differences in concept and procedure are examined. Data from different sources were adjusted for comparability. Percentages calculated from the 1960-61 Consumer Expenditure Survey and

the National Income Accounts were nearly the same; percentages calculated from the 1955 and 1965 *Household Food Consumption Surveys* were much higher. CES data are more representative of a medical family, while NIA data are useful indicators of the trends for the economy.

M. C. Burk. *Food Expenditures by Upper Income Families: An Analysis of their Changing Importance in the U.S. Food Market*, Ag. Exp. Station Technical Bulletin 269 (Minneapolis: University of Minnesota, 1969).

M. C. Burk. "Ramifications of the Relationship Between Income and Food." *AJAE* (December, 1958), pp. 905-922.

This article considers concepts to be used in the analysis of income food relationships and reviews time series and cross-sectional data matching these concepts. A number of income elasticities for food are derived and examined for comparability. Major findings include (1) the relationships of quantity measures to real income have not changed between 1938 and 1958; (2) the level of food marketing services has risen significantly; and (3) this change in the level of food marketing services resulted in higher post-war levels of market value of all food consumed and has contributed to decreases in the value of the farm share.

J. S. Dusenberry. "Some New Income Consumption Relationships and Their Implications." *Econometrica*, Vol. 15, No. 2 (1947).

Louis Albert Fourt. *Empirical Income Elasticities for Food and its Component Values Produced by Farmers, Manufacturers, and other Marketing Agencies, 1929-1956*. Unpublished Ph.D. thesis, University of Chicago, 1959.

R. O. Herrmann. *An Investigation of Differences in Income Elasticities of Demand for Food in Households of Differing Sizes and Composition*, unpublished Master's Thesis, East Lansing: MSU.

W. W. Hicks and S. R. Johnson. "Quantity and Quality Components of Income Elasticities for Food." AJAE, 50 (December, 1968), pp. 1512-17.

This article is concerned with quantity and quality aspects which may result in increased food expenditure. Quantity and quality are both treated as commodities of a food expenditure function. Total differentiation of the expenditure function with some manipulation allows for separation into the two component elasticities.

H. S. Houthakker. "An International Comparison of Household Expenditure Patterns, Commemorating the Centenary of Engel's Law." Econometrica, Vol. 25, No. 4 (October, 1957), p. 53. See Bylund, p. 180.

D. S. Ironmonger. "A Note on the Estimation of Long-Run Elasticities." AJAE, Vol. 41, No. 3 (1959), pp. 626-632.

C. E. V. Leser. "Forms of Engel Functions." Econometrica, Vol. 31, No. 4 (1963).

Richard D. Millican. "A Re-examination of Engel's Laws Using BLS Data (1960-61)." JM 31, No. 4 pp. 18-21.

The source of data is the 1960-61 Survey of Consumer Expenditures. Four assumptions were tested with the data (1) the greater the income, the smaller the percentage of outlay for subsistence; (2) and (3) the percentage outlay for clothing and shelter is approximately the same for each income level; and (4) as income increases, the percentage outlay for "sundries" becomes greater. The first three assumptions were supported by the data. For the fourth assumption only the educated showed an increasing income elasticity as income rose. Food away from home combines food consumption and recreation and tends to be elastic, but gradually regresses toward unity at high income levels.

J. H. Myers; R. R. Stanton; and A. F. Haug. "Correlates of Buying Behavior: Social Class Vs Income." JM 35, No. 4 (October, 1971), pp. 8-15.

This study compares social class and income as correlates of buying behavior for a variance of low-cost packaged goods. About half of the items considered were beverages and foods. The objective was to determine whether social class or income best explains which products are found in the home. With a few exceptions it was concluded that social class is basically inferior to income as a correlate of buying behavior for the consumer of packaged goods.

J. C. Purcell and R. Raunikar. "Quantity Income Elasticities for Foods by Level of Income." AJAE, Vol. 49 (December, 1967), pp. 1410-14.

Relative changes in the demand for specified foods or food groups in the United States depends largely on the response to income. Real income per consuming household is assumed to continue increasing over the course of time at a rate of approximately 1.8 percent per year. The purpose of the paper was to develop alternative functional forms that relate quantity of food purchases to the level of household income and to develop a classification of foods with respect to the magnitude and the form of the response to income. Income elasticities are high for ice cream, beef, lettuce, milk, tomatoes, and citrus fruits. Negative quantity income elasticities were found for cereal products, sweet potatoes and fats. Leafy vegetables and white potatoes showed almost no response to income at all levels of income.

G. R. Rockwell, Jr. "Income and Household Size: Their Effects on Food Consumption." Marketing Research Report No. 340, USDA (June, 1959). See Bylund, p. 176.

Thomas T. Semon. "Family Income and Spending Capacity." JM, Vol. 26, No. 2 (April, 1962), pp. 26-30.

Chester R. Wasson. "Is It Time to Quit Thinking About Income Classes?" *JM*, Vol. 33, No. 2 (April, 1969), pp. 54-57.

Tabulations of the BLS 1960-61 *Survey of Consumer Expenditures* show clearly that the pattern of expenditure allocation has little relation to income level and that effective market segmentation is primarily a result of such social class indicators as occupation and other measures of culture like region, locality, and stage in family life cycle. Whatever validity income classification had was due to a rough and now disappearing correlation with occupational status. Occupational status is more important to market segmentation than income.

B. Psychological Aspects

James A. Bayton. "Contributions of Psychology to Microeconomic Analysis of Consumer Demand." *AJAE*, Vol. 45, No. 5 (December, 1963), p[illegible] 1430-1435.

Psychology can make contributions to the development of a general theory of consumer demand for all food products. These contributions will be in the area of concepts or constructs and methodology. Bayton's thesis is that the unifying theme for research in microeconomic demand analysis for food should be perception. He concludes that such a general theory cannot be constructed, but must await intensive and comprehensive research on the role of psychological factors in the system.

W. J. Bilkey. "Psychic Tensions and Purchasing Behavior." *Journal of Social Psychology*, Vol. 41 (1955), pp. 247-257. See *Bylund*, pp. 134-135.

D. Dickens. "What Homemakers Believe about Food." ABS, Association of Southern Agricultural Workers--Proceedings (1957), p. 172. See *Bylund*, pp. 141-142.

J. F. Engel and M. L. Light. "The Role of Psychological Commitment in Consumer Behavior: An Evaluation of the Theory of Cognitive Dissonance." in F. M. Bass, G. W. King and E. A. Pessimer, eds., *Applications of the Sciences in Marketing Management* (New York: Wiley, 1968).

F. Thomas Juster. *Consumer Buying Intentions and Purchase Probability*. NBER, New York, 1966, 60 pp.

M. G. Holmes and J. D. Shaffer. "Some indications of Homemakers Knowledge about Food Buying Information." *Quarterly Bulletin, Michigan Agricultural Experiment Station*, Vol. 41, No. 3 (February, 1959), pp. 648-659. See *Bylund*, p. 81.

R. L. Kohls and M. B. Minden. "Getting the Attention of the Food Consumer." Indiana (Purdue University) Agricultural Experiment Station, Mimeo. Ec. 152 (November, 1957). See *Bylund*, p. 82.

G. Katona. *Psychological Analysis of Economic Behavior* (New York: McGraw Hill Book Co., 1960).

H. B. Schutz. "Preference Ratings as Predictors of Food Consumption." *American Psychologist*, Vol. 12 (1957), p. 412. See *Bylund*, p. 145.

H. G. Schutz and F. J. Pilgrim. "A Field Study of Food Monotony." *Psychological Reports*, Vol. 4, No. 4 (December, 1958), pp. 559-565. See *Bylund*, p. 145.

N. Schwartz and D. Foster. "Methods for Rating Quality and Intensity of the Psychological Properties of Foods," *FT*, Vol. 11 (September, 1957), pp. 15-20.

A general discussion of the psychological properties of foods, dimensions of response to foods, scales of evaluation (nominal, ordinal, interval, and rational) and different types of scales are presented. Many references are cited.

W. I. Smith and S. Ross. "Note on Food Aversions and Body Build." *Psychological Reports*, Vol. 4, No. 2 (June, 1958), pp. 193-194. See *Bylund*, p. 136.

H. Trier; H. C. Smith and J. Shaffer. "Differences in Food Buying Attitudes of Housewives." *JM*, Vol. 25 (July, 1960), pp. 66-69.

Ralph Westfall. "Psychological Factors in Predicting Product Choice." *JM*, Vol. 26, No. 2 (April, 1962), pp. 34-40.

C. Socioeconomic Aspects

Marcus Alexis. "Some Negro-White Differences in Consumption." American Journal of Economics and Sociology, Vol. 21 (January, 1962), pp. 11-28.

Thomas M. Brooks. Consumer Preferences for Selected Types of Food Packaging. Ph.D. Thesis, Agricultural Economics, The Pennsylvania State University, January, 1961, 144 pp.

The objective of the study was to investigate relationships between consumers' reasons for package preferences and socioeconomic characteristics of consumers. The data is based on a survey of 755 homemakers in Harrisburg, Pa. Convenience was the main reason for selecting one type of packaging over another. The age of the homemaker and family size were related to the emphasis placed on obtaining the quantity most suitable to the family's needs.

M. S. Bryan and M. E. Lowenberg. "The Father's Influence on Young Children's Food Preferences." Journal of the American Dietetic Association, Vol. 34, No. 1 (January, 1958), pp. 30-35. See Bylund, p. 141.

M. C. Burk. Influences of Economic and Social Factors on U.S. Food Consumption (Minneapolis: Burgess Publishing Co, 1961), 135 pp.

C. M. Coughenour. "Functional Aspects of Food Consumption Activity and Family Life Cycle Stages." Journal of Marriage and the Family, Vol. 34 (November, 1972), pp. 656-664.

Parsonian theory of the major functional dimensions of social processes--adaptive, goal gratification, integrative, and pattern maintainance is adapted to the description of the process within the family of food purchasing, meal planning, and food consumption. Measures of the first three dimensions are developed and related to a classification of families by life cycle stage. Data were obtained from a sample of over 4000 homemakers in 7 southern states. Homemaker activities to adapt and integrate the desires of the family were highest when children were present in the family. Goal satisfaction with food consumption was also lowest when children were present.

Joan C. Courtless. "The Effect of Consumer Credit on Food Expenditures." *Family Economic Review* (March, 1971), pp. 22-26.

There is concern that the dietary level of U.S. families is not keeping pace with increases in material prosperity. The proportion of family diets meeting the 1963 Recommended National Research Council actually dropped 10 percent from 1955 to 1965. The hypothesis is that the use of consumer credit is cutting into money available for food. Although only one-eighth of the families surveyed assumed new debt during the survey year, 36 percent of the families making debt payments had to make one or more unplanned cuts in living expenditures to meet payments. Food spending was cited most frequently as the area in which cuts were made.

Claude Dassule. *Effect of Occupational-Prestige Categories on Household Food Expenditures*, M. S. Thesis, Agricultural Economics and Rural Sociology, The Pennsylvania State University, March, 1968.

The hypothesis tested using 1955 *Household Food Consumption Survey Data* is that at a given level of income, families of higher social status spend differently for food than those of lower status. Due to auto correlation, there is no statistically significant difference in mean food expenditures between families of different social status with the same income and family size.

Dorothy Dickins and Alvirda Johnston. *Children's Influence on Family Food Purchase Decisions*, Mississippi State Univ., Ag. Exp. Station Bulletin No. 671 (September, 1973).

Charles Y. Glock and Francesco M. Nicosia. "Uses of Sociology in Studying 'Consumption' Behavior." *JM*, Vol. 28, No. 3 (July, 1964), pp. 51-54.

Edgardo Gonzalez-Villafañe. *The Effect of Homemakers Age, Income, Education and Physical Mobility on the Adoption of New Food Products*. M. S. Thesis, Agricultural Economics and Rural Sociology, The Pennsylvania State University, December, 1961.

Robert O. Herrman. Households Socioeconomic and Demographic Characteristics as Determinants of Food Expenditure Behavior. Ph.D. Thesis, 1964, Michigan State University.

Robert Lee Jack. Decision Stabilization for Six Branded Food Products as a Function of Homemakers Perception of Quality Differences, Temporal Variables, and Socioeconomic Factors. Ph.D. Thesis, Agricultural Economics and Rural Sociology, The Pennsylvania State University, December, 1963.

R. O. Herrman. "Interaction Effects and the Analysis of Household Food Expenditures." AJAE, Vol. 49 (November, 1967), pp. 821-832.

This article is based on 1955 USDA Household Food Consumption Survey Data and seeks to discover interrelatedness among the 10 variables which are usually treated as independent. A major result was that combinations of variables may be important in explaining a behavior pattern. For example, income, household size, and urbanization partitions are important in analyzing total expenditures on food. Food eaten away from home may be best explained by other variable combinations. The variables considered are:

Variables

1. Income
2. Family size
3. Urbanization
4. Region
5. Race
6. Marital status
7. Age of homemaker
8. Presence of children
9. Education of homemaker
10. Employment of homemaker

Herbert Krugman. "The Learning of Consumer Likes, Preferences, and Choices." in Applications of the Sciences in Marketing Management; Bass, King and Pessimer, eds. (New York: Wiley, 1968).

W. Massy; R. Frank; and T. Lodahl. Purchasing Behavior and Personal Attributes, (Philadelphia: University of Pennsylvania Press, 1968).

Jane L. Rees. The Use and Meaning of Food in Families with Different Socio-Economic Backgrounds. Ph.D. thesis, General Home Economics, The Pennsylvania State University, January, 1959. 122 pp.

In the selection of food, consideration for nutrition and/or family preference seems to be of paramount importance to homemakers. Homemakers in the upper socioeconomic category were more likely to consider nutrition, while homemakers in the lower categories tended to consider family preference. Education was the factor most likely related to reasons for the selection of food. Homemakers with more education tended to use a greater variety and more frozen fruits and vegetables. The development of short cuts was more common among upper status categories in food preparation as was the emphasis on aesthetic aspects of meals.

Gary A. Richardson. Socioeconomic Factors Associated with Trying New Grocery Products. M. S. Thesis, Agricultural Economics and Rural Sociology, The Pennsylvania State University, September, 1965, 80 pp.

J. D. Shaffer. "Contributions of Sociologists and Cultural Anthropologists to Analysis of U.S. Demand for Food." AJAE, Vol. 45 (December, 1963), pp. 1420-1429.

The major contribution of sociologists and cultural anthropologists to demand analysis is their contribution to the understanding of human interaction, group membership, and social processes. The economist usually studies prices and commodities. He tends to take tastes and preferences as given, rules out interdependent utility functions, and ignores group membership. However, in order to explain, predict, or influence demand, it is valuable to understand the processes involved in changing preferences and the influence of the group in consumption choices.

Don W. Sauer. The Effects of Ecological Areas on the Trying of New Food Products with Emphasis on Certain Social Economic Variables and Homemaking Activities. M. S. Thesis, Agricultural Economics and Rural Sociology, The Pennsylvania State University, September, 1963, 81 pp.

H. Sharp and P. Mott. "Consumer Decisions in the Metropolitan Family." *JM*, Vol. 21, No. 2 (October, 1956), pp. 149-156. See *Bylund*, p. 132.

David Spaeth and James D. Shaffer. "Relationships of Level of Installment Payments to Family Characteristics and Approach to the Food Budget." *Quarterly Bulletin* of the Michigan Ag. Expt. Station, Vol. 41, No. 3 (February, 1959).

Michael C. Varner. *Competition Between Expenditures for Food for Home Consumption and other Budget Categories at Selected Family Life Cycle Stages*. M. S. Thesis, Ag. Econ. and Rural Sociology, The Pennsylvania State University, June 1973, 144 pp.

The purpose of this study was to identify factors that determine the proportion of income spent for and whose variation over time may cause changes in this proportion. The family life cycle concept was relevant to the determination of variation in other economic factors that affect food consumption. The hypothesis was that a high rate of durable goods purchased by a young-empty nest stage household did not affect its expenditure for food. However, high expenditure and reduced income at this stage did show food consumption negatively. Also home food production and its effect on food expenditures varied directly with the need for cost savings within the budget. Budget strain was reflected by the number of expenditure category variables found to have a negative effect on home food consumption expenditure.

D. Behavior Patterns

T. M. Brown. "Habit, Persistence, and Lags in Consumer Behavior." *Econometrica*, Vol. 20, No. 1 (1952).

N. W. Comish. "What Influences Customer Choice of a Food Store." *Journal of Retailing*, Vol. 34, No. 2 (Summer, 1958), pp. 90-100. See *Bylund*, p. 131.

L. E. Drayton. "Food Consumption Trends, Standards, and Consumer Preferences." *Canadian Journal of Agricultural Economics*, Vol. 5, No. 2 (1957), pp. 15-25. See *Bylund*, p. 142.

R. E. Frank. "Correlates of Buying Behavior for Grocery Products." JM, Vol. 31, No. 4, (October, 1967), pp. 48-53.

L. M. Henderson. "Nutritional Problems Growing Out of New Patterns of Food Consumption." American Journal of Public Health and National Health, Vol. 65, No. 9 (September, 1972), pp. 1194-1198.

Poverty and ignorance are the major reasons for inadequate diets. In the U.S., it has been impossible to eliminate extreme poverty, educate consumers to be sufficiently nutrition conscious, and develop realistic guidelines and standards for convenience foods and snacks whose role in our diets is rapidly changing. The major nutritional problem with eating out is obesity. Because restaurants and institutions employ dietitians, meals eaten away from home tend to be very nutritious. The use of snacks is increasing rapidly and they vary widely in nutrient content.

Ingrid Hildegaard and Lester Krueger. "Are There Customer Types?" New York: Advertising Research Foundation, 1964.

E. C. Hoffman. "Who Responds to Premium Offers?" FB, Vol. 4, No. 4 (April, 1956), p. 16. See Bylund, p. 93.

F. T. Juster. Anticipations and Purhcases: An Analysis of Consumer Behavior (Princeton: NBER, 1964), 303 pp.

This book is concerned mainly with demand for consumer durables. It is referred to when considering the effect durables purchased have on food consumption, although the book does not explicitly cover the subject.

Phillip Kotler. "Behavior Models for Analyzing Buyers." JM, Vol. 29, No. 4 (October, 1965), pp. 37-45.

Herbert E. Krugman. "The Learning of Consumer Preferences." JM, Vol. 26, No. 2 (April, 1962), pp. 31-33.

Eleanor Pao. "Food Patterns of the Elderly." FER (December, 1971), pp. 16-19.

T. J. Paul. "Is It Really Impulse Buying?" FB, Vol. 6, No. 2 (February, 1958), p. 17. See Bylund, p. 131.

B. L. Schapker. "Behavior Patterns of Supermarket Shoppers." JM 30, No. 4 (October, 1966), pp. 46-49.

This article is based on a series of annual studies of supermarket shoppers, conducted since 1954 by Burgoyne Index, Incorporated of Cincinnati. The number of supermarkets are fewer but they are getting larger. The number of shoppers patronizing one supermarket for all food needs has declined. Consumers shop more frequently, readership of food-store advertising has been increasing, more than two-thirds of the volume of trading stamps is handled by supermarkets, and very few shoppers shop exclusively at discount supermarkets.

J. D. Shaffer. "Consumers DO Read Newspaper Food Ads." Michigan Farm Economics, No. 197 (June, 1959), p. 2. See Bylund, p. 84.

H. M. Southworth. "Implications of Changing Patterns of Consumption Preferences, and Motivation." AJAE, Vol. 39, No. 5 (December, 1957), pp. 1299-1309. See Bylund, pp. 176-177.

Hawkins Stern. "The Significance of Impulse Buying Today." JM, (April, 1962), pp. 59-62.

E. Home Food Preservation

Carlos Campbell. "Commercial Canning- What Does the Future Hold?" JM, Vol. 26, No. 2 (April, 1962), pp. 44-47.

"Food Canning by U.S. Households," FER, Con. Food Econ. Res. Division, ARS, USDA (September, 1970).

According to food consumption surveys conducted by the USDA, only 34 percent of U.S. households canned any food for home use during 1964, compared with 44 percent in 1954. Relatively more farm than rural nonfarm or urban households did canning. Only 13 percent of urban households in the northeast canned any food, 25 percent in the northcentral, 28 percent in the south and 27 percent in the west.

Corrine LeBovit. "U.S. Families Still Preserve Foods at Home." NFS 140 (May, 1972), pp. 27-28.

Households surveyed by USDA in 1965-66 canned or froze a little over a tenth of the processed fruits and vegetables they used. Farm families used a much higher proportion of home preserved food than urban families. Comparisons with a similar survey conducted in 1955 shows that the proportion of all U.S. households canning any food dropped 10 percent from 1954 to 1964. Canning at home was more popular than freezing. The choice of items for home processing was similar to the choices of purchased canned and frozen items.

Ruth Redstrom. "Home Food Preservation in U.S. Households." FER (June, 1971), pp. 12-15.

A comparison of 1965 and 1955 HFCS indicates home preservation of food has probably decreased. The proportion of households doing any canning decreased from 44 to 34 percent and percentage of households freezing foods has increased from 19 to 24 percent. Increases in the proportions of households freezing foods were greater for urban areas than the nation as a whole.

F. Brand Loyalty

George Brown. "Brand Loyalty--Fact or Fiction?" Advertising Age XXIII (June 19, 1952), pp. 53-55.

Ross Cunningham. "Brand Loyalty--What, Where, How Much?" Harvard Business Review XXXIV, No. 1 (January-February, 1956), pp. 116-128. See Bylund, pp. 105-106.

John Farley. "Brand Loyalty and the Economics of Information." JB XXXVII, No. 4 (October, 1964), pp. 370-81.

VI. Poverty and Food Consumption

M. Alexis and L. S. Simon. "The Food Marketing Commission and Food Prices by Income Groups." AJAE, Vol. 49 (May, 1967), pp. 436-446.

This article looks at families by 3 income groups and their expenditures on food. Low income groups pay a premium of 10 percent on food due to lack of mobility and shop at independent stores. One main conclusion was that a "V shaped" distribution of prices exists. Higher prices are paid by low and high income groups, but for different reasons.

Guy Black. "Variations in Prices Paid for Food as Affected by Income Level." AJAE 34 (1952), pp. 52-66.

Consumption studies, for which data were collected in 1935-36 and in 1948, show that there is a tendency for prices paid by an income group to be higher than prices paid by lower income groups and less than prices paid by a higher income group, aside from the tendency for higher income groups to buy different and more expensive foods.

The reason for studying the income price gradient is to explain service differences and associated price changes which have taken place in the food merchandising industry.

Helen M. Eklund. "USDA Domestic Food Programs." NFS, Vol. 129, (August, 1969), pp. 26-29.

USDA commodity contributions to needy families, schools, and institutions are presented. Donations represent about 1 percent of all U.S. civilian food consumption. Effect of food stamp program was low in relation to total food spending. 0.6 percent of all food spending was done with food stamps.

S. J. Hemistra. "Food: A Special Issue in Welfare Programs." NFS 131 (February, 1970), pp. 25-29.

Food and nutrition rank high on the list of welfare needs. Income supplements are inefficient in raising level of food consumption of the poor. To eat like the rest of the country, the poor would need to increase food spending by 15 percent. This would increase the total quantity of food demanded by 2-3 percent. Expansion of food programs is needed until broader welfare programs are initiated.

J. N. Morgan. "The Supply of Effort, the Measurement of Well-Being, and the Dynamics of Improvement." AER, Vol. 558 (May, 1968), pp. 31-39.

The article deals with labor force participation characteristics by income distribution. The lower one's wage, the more hours the family head and the family as a whole work. An attempt is made at considering non monetary aspects of family services. The aim of the author is to call for a more precise conceptulization of poverty and inequality to formulate a policy to eliminate poverty.

Periodical	Abbreviation
American Economic Review	AER
American Journal of Public Health	AJPH
American Journal of Agricultural Economics	AJAE
American Journal of Clinical Nutrition	AJCN
American Statistical Association, Proceedings	ASA
Conference Board Record	CBR
Cornell Hotel and Restaurant Administration Quarterly	CHRAQ
Economic Journal	EJ
Fast Food	FF
Family Economic Review	FER
Food and Nutrition Newsletter	FNNL
Food Technology	FT
Hospitality, Food and Lodging	HFL
Industrial Relation	IR
Journal of American Statistical Assn	JASA
Journal of Business	JB
Journal of Economic and Business History	JEBH
Journal of Marketing	JM
National Food Situation	NFS
Review of Economics and Statistics	RESTAT
Quick Frozen Foods	QFF
Southern Economic Journal	SEJ
Vend	VEND

ADDENDA

The five figures that conclude this report were completed after the original papers had gone to press. The first figure (Figure 5) accompanies the section in Dr. Powers' paper entitled "The Impact of Productivity on the Service Restaurant." The following four figures (Figures 1 through 4) accompany the section in Dr. Smith's paper entitled "Food Expenditures as a Proportion of Family Income by Income Class and Family Size."

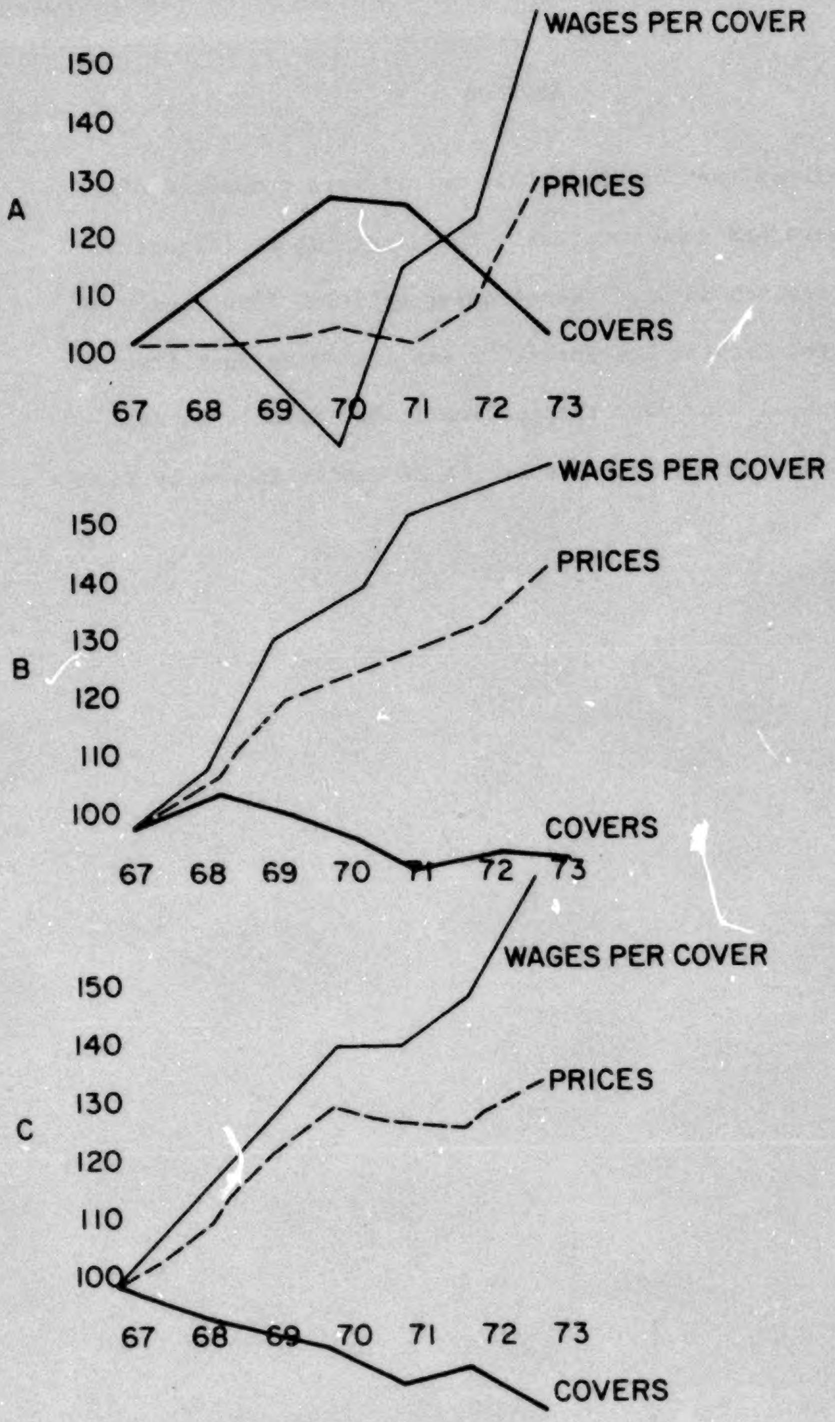
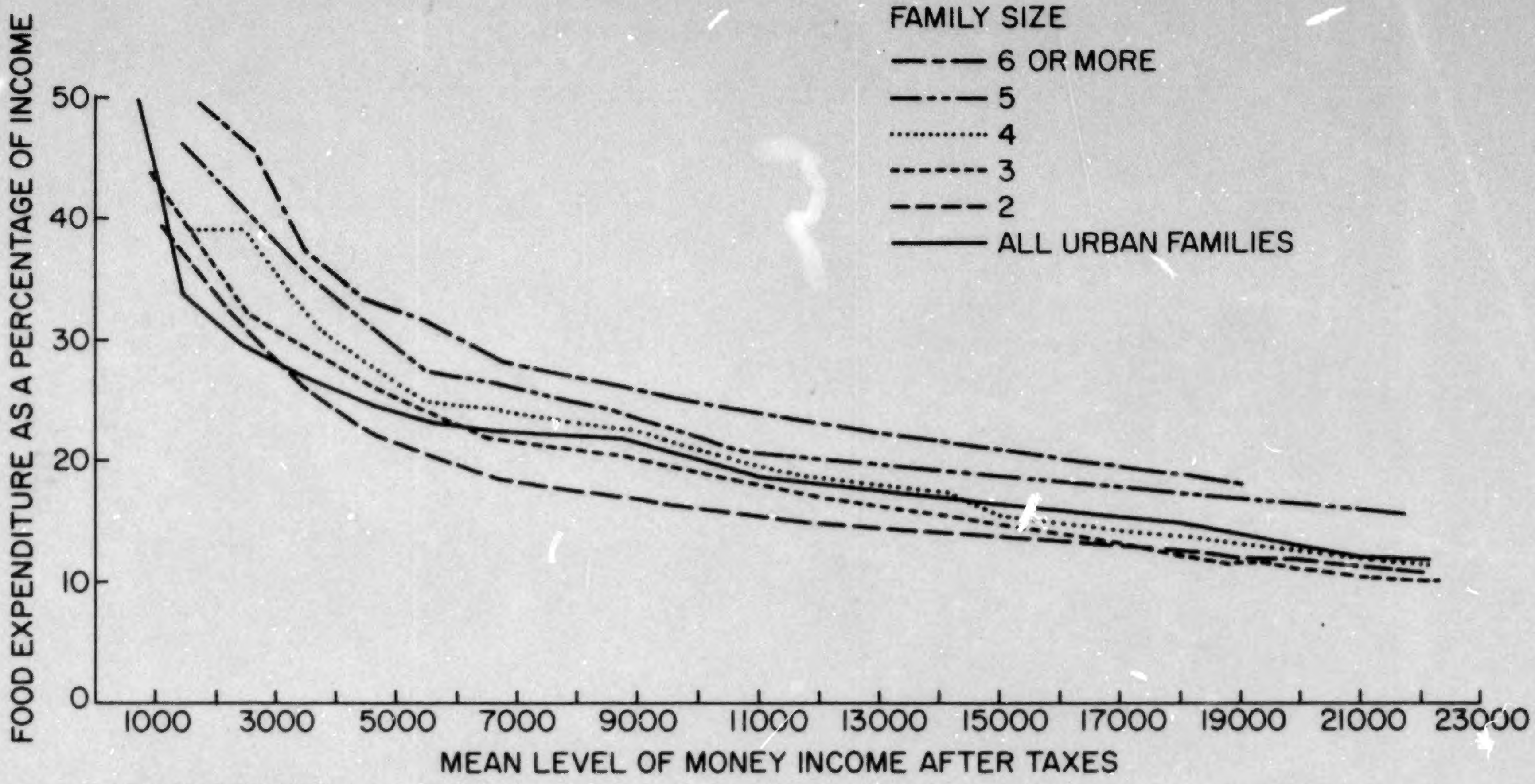
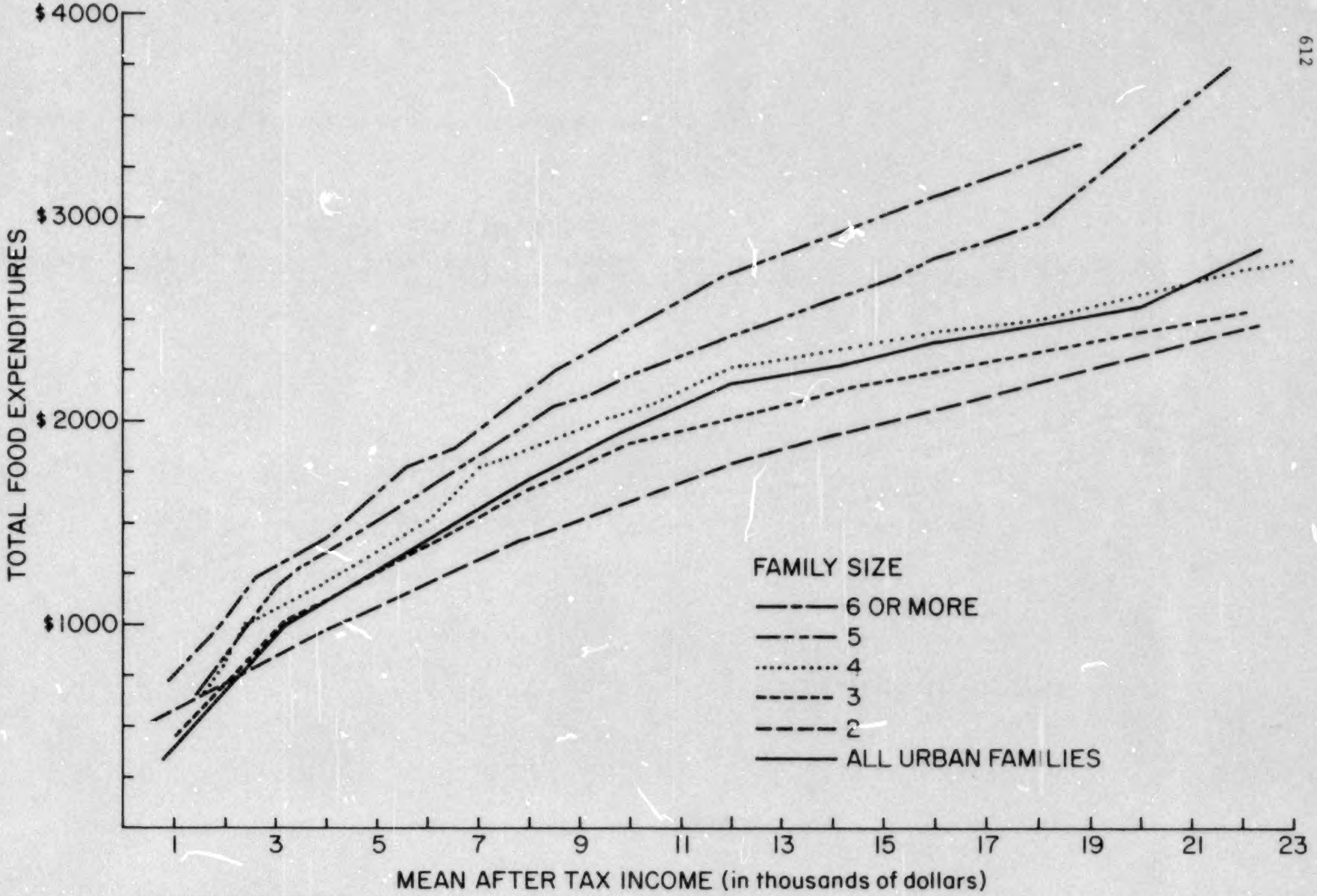


Figure 5. Wages, Check Average, and Total Covers, in Three Food Service Operations.



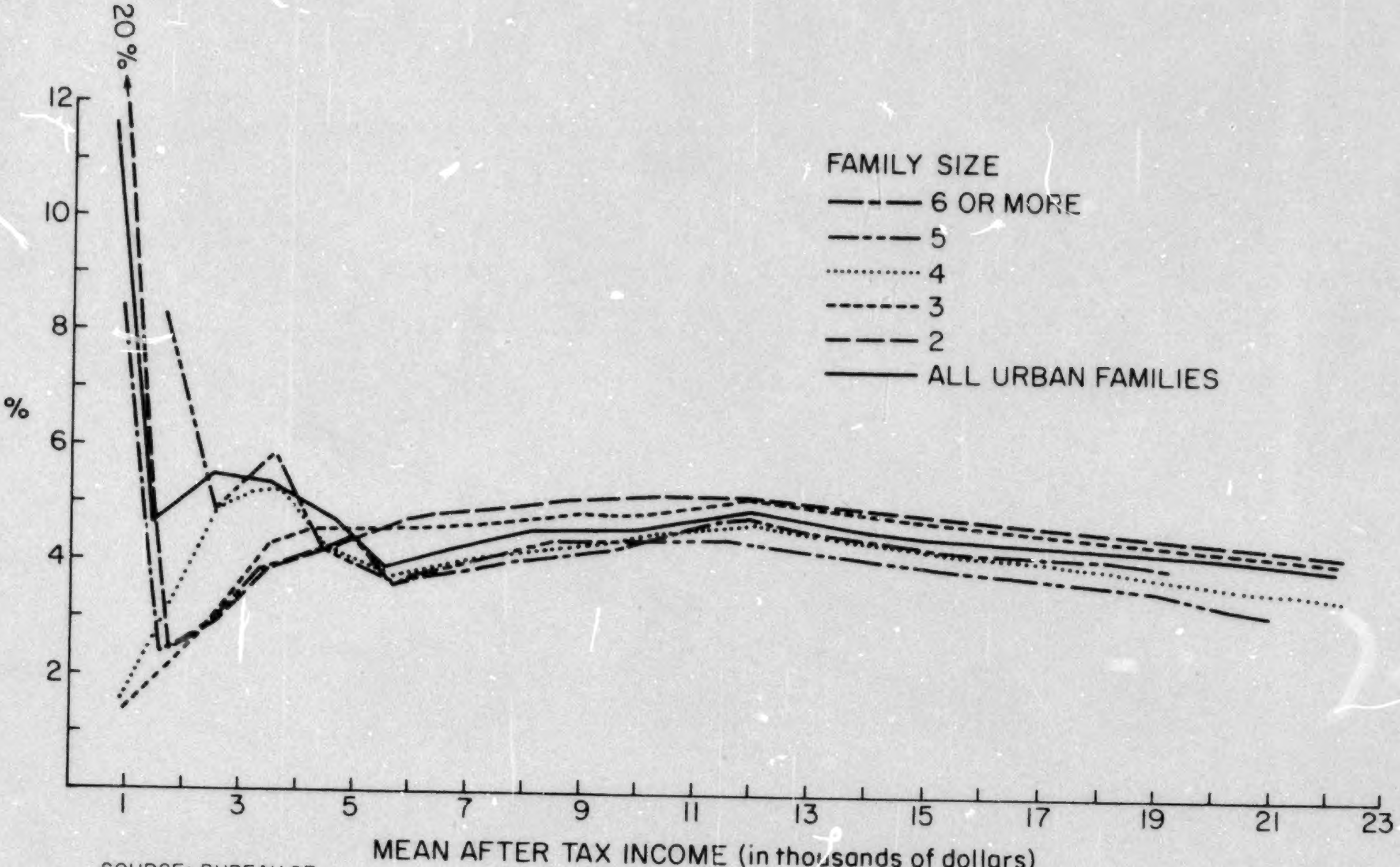
SOURCE: BUREAU OF
LABOR STATISTICS

Figure 1. Total Food Expenditures as a Percentage of Income by Family Size.



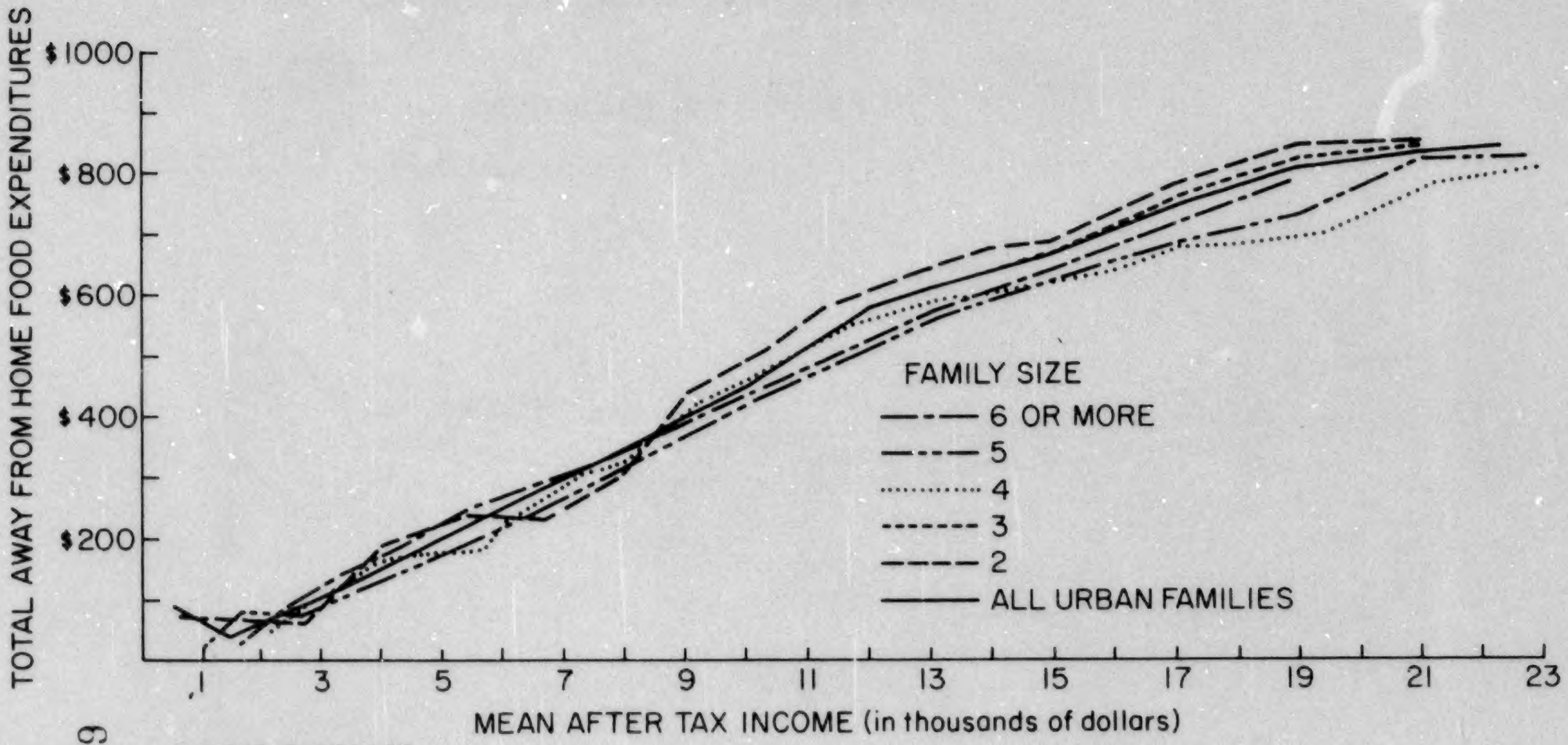
SOURCE: BUREAU OF
LABOR STATISTICS

Figure 2. Total Food Expenditures by Income and Family Size.



SOURCE: BUREAU OF
LABOR STATISTICS

Figure 3. Away From Home Food Expenditures as a Percentage of Income, by Family Size.



SOURCE: BUREAU OF
LABOR STATISTICS

Figure 4. Away From Home Food Expenditures by Income & Family Size.